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CONTENTS

	Page
Control of Atomic Energy	823
Advances in Biochemistry. By Dr. J. H. Quastel, F.R.S.	824
Mathematics of Statistics. By Prof. Godfrey Thomson	826
Phase-Contrast Methods in Microscopy. By Prof. L. C. Martin	827
Marine Biology at Plymouth	830
The Vienna Academy of Sciences (1847–1947). By Dr. Robert W. Lawson; Dr. F. P. Bowden	831
Obituaries:	
Prof. H. S. Jennings. By Dr. Clifford Dobell, F.R.S.	834
Mr. G. H. Tipper	834
Dr. Leopold von Portheim. By Dr. C. R. Metcalfe	835
Prof. J. Velíšek. By Dr. J. G. F. Druce	835
News and Views	836
Letters to the Editors:	
Aromatization of cycloHexane Carboxylate in Liver Slices.—Prof. F. Dickens, F.R.S.	839
Spectroscopic Estimation of Penicillin G.—A. R. Philpotts, W. Thain and Dr. G. H. Twigg	839
Antibiotic Agents in the Substrates from Cultures of the Genus *Marasmius*.—Prof. Elias Melin, Torsten Wikén and Karin Öblom	839
Use of Potassium in the Assay of Curare.—P. G^a. de Jalon and G. B. West	841
Leukotaxine and Histamine.—Dr. H. Cullumbine	841
Serum Bilirubin and the Van Den Bergh Reaction.—C. Gardikas, Dr. J. E. Kench and Dr. J. F. Wilkinson	842
Neutral Auxins.—Dr. Poul Larsen	842
Molecular Weight of Melanin.—A. J. Lea	843
Free Radicals from Benzyl Hyponitrite.—Ivan Harris, Ian Marshall and Kenneth Barry Jarrett	843
Addition of Dinitro'Compounds to D.D.T. to Prevent Outbreak of Spider Mites.—R. M. Greenslade and E. G. Goscombe	843
Autoxidation of Olefins: Formation of Unsaturated Alcohols from Olefins by the Action of Organic Peracids.—Dr. W. J. Hickinbottom	844
The Meson Spectrum Near Sea-Level.—M. Della Corte, T. F. Fazzini and S. A. Franchetti	845
Diffuse Bands on Laue Photographs of Silver Chloride Crystals.—Prof. W. G. Burgers and Tan Koen Hiok	845
X-Ray Diffraction Studies of Yielding in Mild Steel.—J. M. Cowley and M. S. Paterson	846
Recrystallization of Duplex Brass.—R. W. K. Honeycombe and Dr. W. Boas	847
The Harmonic Cord.—Cyril H. H. Franklin	848
Mortality Required to Prevent Population Increase.—M. E. Solomon	848
Collisions of Cloud Droplets.—W. C. Swinbank	849
Silver Chloride Plates for Infra-Red Spectroscopy.—K. S. Tetlow	850
Distortion of Fungal Hyphæ in the Presence of Certain Inhibitors.—J. M. Vincent	850
Production of Contrast in the Microscope Image by Means of Opaque Diaphragms. By Dr. A. F. Hallimond	851
Industry and Research in the Sheffield Area	852
Hardenability of Steel. By F. C. T.	853
Social Value of War-time Medical Research. By Dr. G. Lapage	854
The Irish Pilchard Fishery. By G. A. Steven	855

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CONTROL OF ATOMIC ENERGY

ALTHOUGH freely quoted, the first report of the Atomic Energy Commission to the Security Council of the United Nations, dated December 31, 1946 (see *Nature*, May 3, p. 616), does not yet appear to have been generally available in Great Britain. It is the more important, therefore, that the situation should be repeatedly and publicly discussed, and that the facts and their implications should be made known alike by such means as *Current Affairs*, the December 28, 1946, issue of which was devoted almost entirely to a review by Peter Wright entitled "The Future and the Atom Bomb", and by the series of broadcast talks arranged by the British Broadcasting Corporation in the spring and published in *The Listener* of March 13. Such popular expositions are important adjuvants to the efforts of the Atomic Scientists Association and the survey of the Committee on Science and its Social Relations of the International Council of Scientific Unions, especially when, as in *Current Affairs*, they are documented for further reading.

For that reason the debate in the House of Lords on April 30 on a motion by the Archbishop of York deserves more than passing notice; it was also notable as the first occasion for an authoritative public discussion in the Houses of Parliament on the present political deadlock regarding the atomic bomb. The statement made on June 11 on behalf of the Soviet Government by Mr. Gromyko, although it suggests movement towards the views of the remainder of the Atomic Energy Commission, is still not clear on the subject of the proposed international authority and its autonomy.

The main theme of the Archbishop of York's speech was the urgency of the situation; but there was a striking similarity in the trend of his thought to that in the latest report of the President of the Carnegie Institution of Washington. Commenting on the bearing on the Institution's work of this scientific revolution in warfare which has given the application of science a central place in national security, Dr. Vannevar Bush recognizes that there is an important time factor, and that the principal question is whether there must be another demonstration of the power of applied science to destroy before mankind realizes that a new approach towards international functioning is demanded; but he also urges that the race between the power of weapons and the power of understanding is not altogether one-sided. Dr. Bush points out that the application of science has done more than create a destructive power which has made a world organisation essential: it has also provided the means of swift communication and transport which make real unity possible, and progress in medicine has done much to make possible that healthy outlook on life which is necessary for great movements of collaboration. The Archbishop of York, while not regarding as necessarily fatal the Russian insistence on a prior convention outlawing the use of the atomic bomb, provided that agreement could be reached as to the destruction of bombs not handed over to the authority as soon as that authority is effectively established,

believes that the limitation on inspection is a most serious difficulty, and that the dangers are very real unless an international authority is speedily brought into existence. Nor can there be any effective authority, in his opinion, unless it is able to override national sovereignty at least to some extent. The first and most practical step towards the abolition of war is the creation of an authority with real power of control and inspection.

Here Dr. Garbett took up a position which men of science have consistently occupied from the start, and he went on to urge in words reminiscent of General Smuts' presidential address to the British Association at its centenary meeting, that the position has arisen because man's immense advances in scientific knowledge have not been accompanied by corresponding advances in moral stature. Lord Cherwell, who followed, at once agreed with what Dr. Garbett said both on this point and especially on the necessity of the nations agreeing to transfer some part of their sovereign independence to an authority able to administer the law and enforce order; his main disagreement with the Archbishop being on the latter's comments on the Bikini experiments. Lord Cherwell made it clear that he rests his own hopes chiefly on proceeding along the lines outlined in the American plan, which he considers is realistic, detailed and carefully thought out. While nations cling to the inviolability of national sovereignty, there is, he believes, little hope of achieving any useful result in the negotiations. Without some authority to enforce the law, and standing above all the members of the community, the best laws in the world are of little avail.

It cannot be said that in this debate there was any clear indication as to how the deadlock created by the Russian attitude can be resolved. Earl Russell insisted that the fundamental question is not of Russian interests, American interests or British interests; but of human interests. Ultimately, it is a question of the abolition of war, and if it is possible that the attempt to isolate and to deal separately with the atomic problem is a mistake, it may none the less be valuable if we can demonstrate, even in a limited field among the nations willing to participate, the practicability of an international authority such as the Lilienthal Report has outlined. That was Lord Lindsay's contention; and Viscount Addison, reviewing the position for the Government, could say but little more than that the technical committee has reported unanimously to the Atomic Energy Commission that it is possible to extend among all nations the exchange of basic scientific information on atomic energy for peaceful ends; to control atomic energy to the extent necessary to ensure its use only for peaceful purposes; to ensure the elimination from national armaments of atomic weapons; to provide safeguards by way of inspection and other means to protect complying States against the hazards of violations and evasions.

These, as Viscount Addison said, are four vital conclusions, but they represent only a small step forward; and although the Atomic Energy Commission has now been asked by the Security Council to resume its work, it would seem that the main hope of progress lies in the formation of a public opinion—in Great Britain and in other countries—which fully understands what is involved and is determined that the price of peace shall be paid, no matter what sacrifice of national sovereignty is required. What needs to be grasped as firmly and widely as possible is that technical opinion is agreed as to the feasibility of control, and that such control means some surrender of national sovereignty. It is the task, then, of those who have understood this issue to bring home to their fellow citizens that this is now a matter of human rights, and of one of those four human freedoms with which President Roosevelt touched the imagination of the freedom-loving peoples. Here, as in the matter of an international police force, it must be made clear to all where the threat to human rights arises, and exactly where progress is being obstructed. Nothing has yet emerged from the debates of the last eighteen months which suggests that any wide deviation is likely from the principles outlined in the Baruch plan. While men of science, through the Atomic Scientists' Association and in other ways, continue to address themselves to this task of educating world opinion, they should equally continue the detailed discussion of the plan on which so much time has already been spent; they should seek to formulate an international document in which the exact nature and mode of operation of an international authority are clearly stated, and work to secure its demonstration in practice in as wide a field as is possible.

ADVANCES IN BIOCHEMISTRY

Advances in Enzymology and Related Subjects of Biochemistry

Edited by F. F. Nord. Vol. 6. Pp. x+563. (New York: Interscience Publishers, Inc., 1946.) 6.50 dollars.

THE articles contained in "Advances in Enzymology", like those in the "Annual Reviews of Biochemistry", are becoming increasingly indispensable to research workers, teachers, and writers of text-books on biochemistry. Reviews of the progress made in the various branches of this rapidly expanding science have become essential to all who wish to keep abreast of the literature. The writers of these reviews have great responsibilities, for their readers look to them not only for an authoritative exposition of recent advances but also for an unbiased judgment on the new developments and for full acknowledgment of the work of all research workers who have contributed to the advances. This duty of fair presentation and appraisal is usually faithfully carried out. This seems clearly to be the case, so far as the writer is able to judge, with the articles in the volume of "Advances in Enzymology" under review.

Dr. E. F. Gale writes a very useful and timely article on the subject of bacterial amino-acid decarboxylases, a subject to which he himself has made very important contributions. These enzymes are responsible for the breakdown, in bacteria, of amino-acids to amines, and Gale has shown that they are formed within bacterial cells in response to certain well-defined conditions of growth. The enzymes have

been obtained and studied in cell-free condition. Dr. Gale's article describes in detail the conditions necessary for the formation of the amino-acid decarboxylases, the manner in which enzyme production is affected by the amino-acid in presence of which the bacteria are grown and the importance for the process of decarboxylation of a coenzyme, which the work of Bellamy and Gunsalus, and of Snell, has shown to be pyridoxal phosphate.

Reviews of the biochemistry of amylases are written by R. H. Hopkins and by W. F. Geddes. It is now more than a hundred years since Payen and Persoz (in 1833) applied the name diastase to the starch-splitting enzymes of barley malt; this name persisted until recent times, but the term amylase is now preferred. Although there is no general agreement, according to Geddes, on the number of enzymes which are involved in starch hydrolytic breakdown, two main types are required, namely, β-amylase, the so-called saccharogenic amylase, and α-amylase, the dextrinogenic and liquefying amylase. Hopkins' article deals with the general features of α- and β-amylases, describes the influence of ions on these enzymes and discusses their stabilities and kinetics. He considers that α-amylase "is the fundamental amylase with its high affinity for starch and its power of relatively rapid dextrinization" and that β-amylase "fulfils the role of an accessory which speeds up and completes the process of saccharification". Geddes' extensive article not only describes the occurrence and properties of the amylases and other starch-splitting enzymes, but also gives a very useful survey of the biochemistry of bread-making and of the part played by amylases in this process. The article describes the amylases of sound and germinated wheats, the factors affecting the maltose value of wheat flour, and the relation between autolytic maltose production and flour gassing power. The article is an important one, not only for its information on amylases but also for an appreciation of the significance of these enzymes in milling and baking technology.

Another enzyme, adenosine triphosphatase, is the subject of an article by Engelhardt. This article deals with the enzymic properties of myosin, the muscle protein, which is capable of bringing about the hydrolysis of adenosine triphosphate. This molecule "is the last link in the long chain of reactions which make available for the performance of mechanical work the chemical energy enclosed in the carbohydrate molecule. The principal agent that performs this work is the protein, myosin, which constitutes by far the predominant part of the solid structure of the muscle fibre and which is unanimously regarded as the contractile substance of muscle." Engelhardt's article gives a detailed description of the purification and crystallization of adenosine triphosphatase, and of the stimulating work of Szent-Györgyi and his colleagues in this field of muscle chemistry. The article not only deals with the characteristics of the enzyme activities of myosin but goes on to the discussion of "mechano chemistry", a term which is meant to embrace those physical, or physico-chemical, changes undergone by the contractile substance of muscle, which are related to its mechanical properties and which are induced by substances produced by the "functional metabolism of muscle tissue". It appears to be manifest that the union between myosin and its substrate, adenosine-triphosphate, brings about physical changes in the protein which are directly connected with muscle contraction. A new phase in our knowledge of muscle chemistry has opened up, and Engelhardt's article is a good introductory survey.

Muscle chemistry also forms the subject of an interesting article by Hoagland of the states of altered metabolism in muscle diseases. When it is realized that striated muscle makes up about 42 per cent of the total weight of the body, and that so much fundamental information concerning normal mechanisms in this organ is known, it seems strange, as Hoagland says, that so little should be known of the biochemical origins of muscle diseases. Hoagland describes succinctly what is known of the metabolic changes in muscular atrophy and hypertrophy, and the degenerative changes in muscle due to deficiency of vitamin E. He discusses, from the point of view of metabolism, the grave muscular diseases of myasthenia gravis, myotonia, familial periodic paralysis, and progressive muscular dystrophy.

Biological antagonisms between structurally related compounds form the subject of a stimulating article by Dr. D. W. Wooley. The biological competition between structurally related molecules, first discovered in the study of enzyme systems, has become of great importance in the search for substances that will affect the growth and metabolism of micro-organisms. The successes and the failures which have attended efforts to evolve microbial antagonists, by creating molecules the chemical structures of which are related to those of substances known to be essential for the metabolism of the bacteria, for example, the vitamins, are described by Hoagland. He indicates the various possibilities and limitations of the present lines of inquiry.

Dr. M. G. Sevag writes a long and interesting article (94 pages with 218 references) on enzyme problems in relation to chemotherapy, which cannot be adequately summarized here. The article should be read by all concerned with investigations of biological antagonisms, of the effects of biological inhibitors on enzyme systems, of adaptive enzymes, of mutations induced by toxic agents and of other relevant phenomena. Dr. Sevag states that it has been his aim "to present the action of toxic or bacteriostatic agents, mutations, resistance and immunity as interrelated processes in micro-organisms". He concludes that the experimental data pertaining to the action of toxic or bacteriostatic agents seems to show that their effects are primarily on the respiratory enzymes. His article, without doubt, merits close attention by all workers interested in the bearing of enzyme chemistry on chemotherapy.

Dr. C. E. Clifton presents an able summary of our present knowledge of microbial assimilation, the process in which synthetic operations occur in the cell simultaneously with breakdown (chiefly oxidative) processes. His objective is "to consider the studies dealing with the assimilatory processes of nonphotosynthetic micro-organisms and to attempt as far as possible to correlate observations on the relation between the anabolic and catabolic activities of microbial life". Dr. Clifton gives a detailed and valuable account of many experiments (including some of those of himself and his colleagues) on the oxygen consumptions of resting, or washed suspensions, of bacteria in presence of organic compounds and on the simultaneous assimilation of a portion of the substrate by these organisms.

All biochemists interested in the significance of acetyl phosphate in intermediary metabolism will do

well to read Dr. F. Lipmann's article on this subject. Use of the isotope technique has thrown acetic acid into prominence as a probable source, in the body, of complex organic molecules. Lipmann's work on acetyl phosphate shows a possible way in which acetic acid is likely to enter into the synthetic operations of the cell.

Limitations of space forbid more than mention of the interesting article by Dr. K. C. D. Hickman and Dr. P. L. Harris on tocopherol interrelationships, in which they examine the physiological activities of the E vitamins in terms of oxidation control and conclude that α-tocopherol has a more fundamental function, at present not understood. Nor is there room to describe the lengthy (79 pages, 355 references) but most instructive article by Dr. Frankenburg on the chemical changes in the harvested tobacco leaf. Indeed, this article deals only with those changes attending the curing process; a later article will deal with the changes taking place during fermentation.

J. H. QUASTEL

MATHEMATICS OF STATISTICS

Mathematical Methods of Statistics

By Prof. Harald Cramér. (Princeton Mathematical Series, 8.) Pp. xvi+575. (Princeton, N.J.: Princeton University Press; London: Oxford University Press, 1946.) 33*s*. 6*d*. net.

A First Course in Mathematical Statistics

By Prof. C. E. Weatherburn. Pp. xv+272. (Cambridge: At the University Press, 1946.) 15*s*. net.

THESE two books at once invite comparison with Maurice Kendall's "Advanced Theory of Statistics" and A. C. Aitken's "Statistical Mathematics". All four are mathematically flawless, and they all require from the reader some mathematical training and ability, but not to the same extent, nor are they all addressed to quite the same category of scientific workers. Kendall, in his preface, called his "a book on statistics, not on statistical mathematics" and declared his intention "to keep the mathematics to heel". Cramér's book (based on his Stockholm lectures since 1930) is very definitely for the mathematician, and its avowed purpose is to join the two lines of development due on one hand to the British and American schools of statisticians, and on the other to the rigorous work of French and Russian mathematicians in developing the calculus of probability. The first twelve chapters are a purely mathematical introduction, dealing with the properties of sets, Lebesque integrals, Fourier integrals, matrices and quadratic forms, and the like, preparatory to the later chapters on random variables, probability distributions, and statistical inference. The author advises the reader to jump to Chapter 13 after reading the first three chapters and a few other paragraphs, and thereafter to use this earlier part only as needed. The advice is good, and for my part I would say jump to Chapter 13 at once. Many who ought to read the book would be highly discouraged by the apparent irrelevance of those first three chapters, yet might turn to them without dismay later after seeing their use and necessity.

Weatherburn says in his preface, "the subject treated in the following pages is best described not as Statistical Methods but as Statistical Mathematics, or the mathematical foundations of the interpretation of statistical data". His book does not make such demands on mathematical ability as Cramér's, and is addressed more to practitioners. It is indeed based on lectures to graduates and undergraduates whose researches and studies were in agriculture, biology, economics, psychology, physics and chemistry. They cannot, however, have been a random sample of the students of those disciplines, I imagine. For those who can follow, however, Weatherburn's book is excellent. The chapter on the properties of Beta and Gamma functions, the use of which in discussing tests of significance is a feature of the book, thoroughly justifies the author's claim that it is clear and simple and does not demand any previous knowledge of these functions. Moment-generating functions are used quite a lot (as also by Aitken), in contrast to Cramér's book, where they are never mentioned except possibly in one exercise. I am surprised that the psychologists at least among Weatherburn's hearers did not ask for an earlier treatment of partial and multiple correlation. When he does come to them, he deals very neatly with the maximum correlation between one variable and the weighted sum of two others, and then simply directs attention to the validity of the argument also for n others. He does not mention, however, the problem of maximum correlation between two 'batteries' of variables, nor refer anywhere to Harold Hotelling. Neyman, too, receives only a passing reference, in a footnote, and Egon Pearson the same.

I mention these facts about Weatherburn's book not to criticize, but to assist the reader in knowing what to expect in it. Its great virtue is its compactness of argument, which facilitates seeing the whole. For example, he deals with fiducial limits in two paragraphs only, for the fiducial limits of a mean, using σ in the earlier paragraph, and its unbiased estimate s in the later; but the principle is shown clearly, though the words "fiducial limits, or confidence limits" on p. 122 rather suggest a confusion of the theories of Fisher and of Neyman–Pearson. Similarly, the term 'maximum likelihood' occurs only once in the book; but the paragraph which contains it (par. 77) puts the matter with extreme clearness. It may be, however, that anyone not knowing of its importance beforehand would pass over the paragraph without full appreciation. That is the danger of compactness and austerity. Kendall's book is warmer and more inviting.

In his Chapter 34, Cramér, after mentioning the two modern methods of outflanking Bayes' postulate, Fisher's *fiducial probabilities* and Neyman's *confidence intervals*, confines his treatment in the main to an account of the latter theory. In the succeeding chapter, on the general theory of testing statistical hypotheses, he deals further with the Neyman–Pearson theory and its basic idea of trying to reduce the chances *both* of rejecting a hypothesis when in fact it is true, and of accepting it when it is false.

On p. 520 Cramér begins a three-page discussion of the problem which leads to the Behrens test, namely, the problem of determining, from two independent samples, whether the means of two populations differ significantly, their standard deviations being also unknown and not necessarily equal. This is described, in Kendall's book, as a crucial problem for the rival theories of fiducial probability and confidence intervals. I speak with great diffidence, for the matter is difficult; but there does not appear to be any recognition of this in Cramér's book.

GODFREY THOMSON

PHASE-CONTRAST METHODS IN MICROSCOPY

By Prof. L. C. MARTIN
Imperial College of Science and Technology

IF we place, on the stage of a microscope, a slide coated with a thin but opaque metal film pierced by small apertures of distinctive shapes and sizes, there is no doubt as to how its image should appear. We expect to see a dark field surrounding bright areas geometrically similar to the apertures, though on a larger scale. Suppose, however, that the object is a very thin section of some biological structure, for example, a nerve with many component fibres. The various parts of the cellular structure have little difference in their relative transmission for ordinary light, and only differ optically in their refractive indices. What should the image look like?

It is known from experience with the first type of object that the exact geometrical relations between object and image are most closely preserved when the numerical aperture of the illumination is adequate to fill the aperture of a perfectly corrected and truly focused objective; but if we apply such conditions to the 'section', the image will probably give little indication of any object-structure. The microscope is then telling us that there are no considerable differences of opacity in this object.

It is possible to overcome the difficulty by resorting to methods of 'staining', or using, say, ultra-violet radiation of a wave-length for which the structures may show marked differences of transmission; but both these methods are attended by certain difficulties and disadvantages which need not be detailed here. In spite of their great technical value, they are not always suitable or possible; thus any method which uses ordinary light, and more or less ordinary microscope equipment, offers much attraction.

Familiar experience shows that if the aperture of the illumination is drastically restricted when viewing such a section, the image will show a pattern in which the distribution of light intensity has at least *some* geometrical relation with the structure of the object in terms of refractive index, but it is not generally clear how the image is to be interpreted in detail, apart from its broader features. Alternatively, dark-ground illumination may be employed, in which a pattern is obtained, again with some broadly similar geometrical features, but with marked differences in the expression of detail and with highly accentuated contrasts. In both images any relatively large areas of uniform thickness and refractive index will be rendered uniformly light and dark respectively in the cases of bright and dark fields; the brightness of the image changes only in regions where there are marked variations of optical path in the object.

Phase-contrast offers a means, within certain limits, of relating the brightness to the magnitude of the optical path and not merely to its changes.

Let us confine attention for the time being to a theoretical case in which the illuminating beam is 'parallel', that is, the numerical aperture is zero. Fig. 1*a* is intended to suggest how the direct light and the diffracted beams meet in the image plane. The diffracted beams are suggested by the broken lines. In such a case it was shown by Lummer that, if the objective aperture were large enough to take in *all* the light transmitted and diffracted by the object,

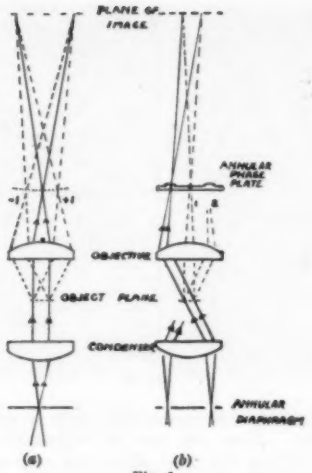


Fig. 1

the image would represent the object both in intensity and relative phase; that is, we should see differences of brightness corresponding to the differences of transmission in the object; and moreover, if some parts of the object cause a greater optical path than others, the light in the corresponding parts of the image would exhibit a proportionate retardation of phase. However, this is not immediately helpful as regards visual distinction, since the eye cannot pick out such phase differences; it can only appreciate differences of brightness in the field.

One of the most interesting contributions to the theory of the interference of light which has been made in recent times is the suggestion of F. Zernike that we can render these phase differences visible by adding (or 'subtracting') a uniform background of coherent light. Where the phase of the background agrees with that of the field the brightness will be enhanced; where the phases are opposite there will be a loss of light. We can look on the light leaving the object plane as 'the unaffected wave *plus* certain diffraction waves produced by the structures'. While the diffracted light is widely spread, the direct light will be brought to something approaching a physical focus in the upper principal focus of the objective before it spreads out to fill the image field and form (together with the 'diffracted' waves) this invisible image expressed in terms of phase variation; but suppose we place in the focus of the direct beam a thin plate of phase-retarding material (a 'phase strip') so small in area that we can neglect without much error its effect on the diffracted waves. Once more we can apply the above idea; the wave leaving the phase strip can be regarded as the incident wave plus a wave due to the strip. We thus add (in effect) a uniform background of coherent light to the original image, and the differences of phase of the image (corresponding to difference of path in the object) become visible as differences of brightness.

The above ideas may be symbolized in the vector diagram, Fig. 2, where OA represents the amplitude and phase of the incident wave; it passes through a certain element of the object and is retarded in phase. The result is now represented by OP, which we can look upon as the incident wave OA plus the diffracted wave OQ. Again, the incident wave OA passes through the phase strip, where it is retarded by 90°,

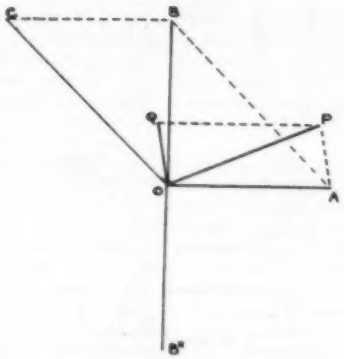


Fig. 2

thus becoming OB (note that OQ is regarded as unaffected). Now OB can be represented by OA plus OC. Thus the final effect can be looked on as due to: (*a*) the incident wave (unaffected) (OA); (*b*) the 'wave' generated by the element (OQ); (*c*) the 'wave' generated by the phase strip (OC). We can look on the 'wave' OC as adding the 'uniform background of coherent light'. In effect, of course, the resultant is the sum of OQ plus OB. This summation is effected in Fig. 3*a*, where the resultant amplitude is represented by OR. Suppose now that various parts of the object exhibit regions of small phase-changes for which the 'diffracted' waves in the above sense are OQ_1, OQ_2, OQ_3, etc. (Fig. 3*b*). Then when the original wave has been subject to the 90° phase change the resultants will be OR_1, OR_2, OR_3, and the corresponding intensities in the image will correspond to the squares of these amplitudes. We shall now have a *differing intensity corresponding to the differing phase*, and this is an important gain. The *relative* differences can be enhanced if the amplitude of the direct beam is cut down at the same time that its phase is changed (this can easily be effected by suitable absorbing material, see below). Then its amplitude can be represented by the shortened line OB^1 (Fig. 3*c*), and the relative amplitudes of the final resultants by OR_1^1, OR_2^1, etc., which have a larger relative variation.

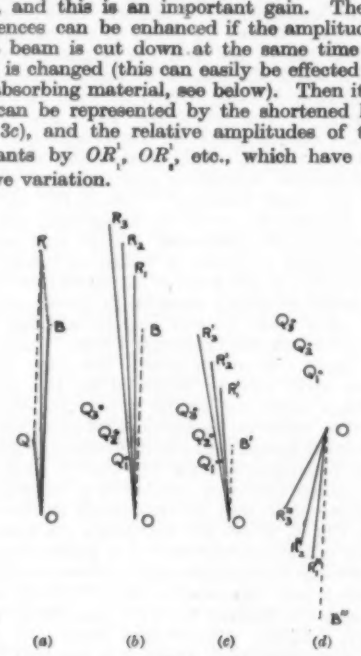


Fig. 3

Again, it is possible so to arrange matters that the phase of the direct light is accelerated with regard to the diffracted waves; then the vector OA (Fig. 2) is shifted to OB^{11}, and it will be clear that the resultants OR_1^{11}, OR_2^{11}, etc. (Fig. 3*d*), have reversed their relative order of magnitude. Hence the contrast is reversed, and the picture will be a negative of the previous one (negative phase-contrast).

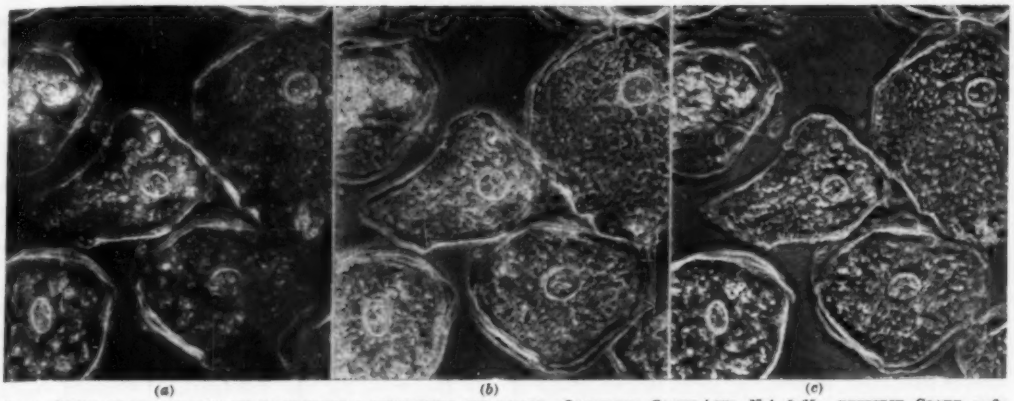
The above considerations should help to make clearer the answer to the question which is commonly put regarding phase-contrast. It is this: We are told that in order to establish the best resolution in the image we should employ the widest possible cone of illumination; on the other hand, phase-contrast methods demand a drastic restriction of the numerical aperture of the illumination. Shall we not therefore lose resolution and therewith the truthfulness of the image?

In answer, it is admitted at once that if the object is one consisting mainly of opacity variation, then the best image is obtained by using the widest possible cone of illumination; if good contrast cannot be obtained with such illumination (as compared with the contrast of the object) then the spherical correction of the objective is suspect, or much stray light may be present. On the other hand, one can only speak of resolving power in relation to a 'phase-variation' object when some means exist of making the structure visible to the eye, with some ascertainable degree of geometrical verisimilitude. If we use a narrow aperture and very oblique illumination, we can, it is true, often obtain evidence of reasonably large phase-variation in fine-structured detail as readily as if a similar opacity structure were present, but if the phase-variations are small the possible brightness differences will be very small also. Using the Abbe principle, it can be said that generally if the angle of a parallel illuminating beam is reduced from the greatest possible obliquity to a direction parallel to the axis, the minimum resolvable interval for a regular structure is increased by a factor of approximately 2; but this depends entirely on the presence of a phase-variation in the object of adequate amount; if the phase-variations are very small, there may not be sufficient contrast in the image to obtain visual resolution of the structure in either case. The discussion of the resolving limit for phase-variation structure has thus no meaning apart from the specification of the phase-angles concerned; for these determine the possible visual contrast.

According to Zernike, phase-contrast has no special use where large phase-variations, say 180°, are concerned; it will, on the other hand, easily render visible phase-differences of very small angle, say 5°–10°; moreover, the phase-step is seen as a step of brightness between two uniform corresponding parts of the field, not merely as a halo or dark fringe.

It need not, therefore, be feared that the phase-contrast method must always result in a 'loss of resolution'; unless, indeed, the object is one of mixed opacity and phase-variation, which is a case requiring special study.

In practice, the simplest arrangement for producing phase-contrast would require a central circular aperture stop in the lower focal plane of the condenser; this would produce a roughly parallel beam through the object. The phase-plate then occupies a position, in the upper focal plane of the objective, conjugate to the aperture stop. In order to increase the light available for the image, the stop can be elongated to a broad slit; but directional differences then become



(a) (b) (c)

Fig. 4. COMPARATIVE PHOTOGRAPHS OF EPITHELIAL CELLS FROM THE MOUTH. OBJECTIVE, COOKE 4 MM., N.A. 0·65; EYEPIECE, COOKE, × 6; BELLOWS EXTENSION, 40 CM.; MAGNIFICATION, × 300. (*a*) DARK-GROUND; (*b*) POSITIVE PHASE-CONTRAST; (*c*) NEGATIVE PHASE-CONTRAST. REPRODUCED BY COURTESY OF MR. E. WILFRED TAYLOR

manifest. In practice the most satisfactory form of the condenser stop is thought to be an annular aperture having a mean radius corresponding to about $\frac{1}{2}$ to $\frac{2}{3}$ of the numerical aperture of the objective, and a width about $\frac{1}{15}$ of this aperture. The phase-plate then has a corresponding phase-changing ring, as suggested in Fig. 1*b*. This arrangement is intended to minimize any loss of resolution.

A retarding ring can be made by vacuum deposition of some suitable material, say calcium fluoride, on the surface of a plane parallel plate; such a ring will usually require protection. Rings can be etched into a similar plate with dilute hydrofluoric acid; and we can thus obtain plates in which the diffracted components suffer greater retardation than the direct light; this is equivalent to an acceleration of the direct light, and would give negative phase-contrast.

If it is desired to diminish the intensity of the zero-order component, the area of the phase-ring only may be coated with a thin film of metal, say, aluminium, by vacuum distillation.

Alternatively, strips or rings of the desired form can be cut from nitro-cellulose, gelatine, etc., which can be made 3μ–6μ thick; these may be cemented in a medium having a refractive index differing somewhat from that of the strip. A very precise control of the retardation is thus possible. Gelatine strips can be dyed to give more or less neutral or selective absorption. The upper focal plane of low-power lenses can be furnished with a thin glass plate bearing a suitable ring; but this arrangement will not serve for high powers, where the principal focus may lie within the lens; in such a case the phase-ring may be borne by one of the interior surfaces. It is thus a considerable advantage to have a special set of objectives fitted with such phase-rings. They will not be ideal for use apart from the phase-contrast method, but at any rate if the phase-ring is non-absorbing the disturbance to the phase-relations in an ordinary image will correspond to the well-known 'Rayleigh Limit', which roughly marks the bounds of discriminable effect. Objectives so fitted can be thus used for ordinary purposes with little risk.

Messrs. Cooke, Troughton, and Simms, Ltd., of York, are producing special sets of objectives, together with the accessory condenser apertures, etc., and the method was recently explained and demonstrated by Mr. E. Wilfred Taylor at a meeting of the Royal Microscopical Society. He showed photographs of biological objects involving the discrimination of extremely small path-differences in flagellæ, etc., which were clearly brought out by phase-contrast. It was clear from such photographs that the images obtained may differ considerably from those obtained by normal methods, and careful attention to the interpretation will be necessary.

Still more recently, Mr. Taylor has made and described a new phase-contrast microscope in which a controlled variable amplitude for the 'direct-light' component is obtained. It is thus possible to adapt the instrumental conditions to suit various types of phase-variation in the object detail. Polarized light is employed, and the necessary relative amplitude variation is secured by the use of a plate, built from concentric annuli of right-handed and left-handed quartz, to carry the phase-changing annulus in the upper focal plane of the objective.

It may be possible perhaps to develop some scheme whereby artificial phase-step objects can be made and included in microscope slides of objects to be studied; the photometric scale for such steps could then be established in terms of the corresponding path differences; this would (for a section of known thickness) enable an approximate determination of relative refractive indices to be carried out, which would be a step towards the identification of parts of the structure. Methods of an analogous kind are well known in connexion with doubly refracting materials. The 'artificial objects' could be minute crystallites or photographic step-wedges in gelatine, etc., mounted in balsam of suitable refractive index.

It cannot be said that the practical use of phase-contrast is yet as fully understood as it should be. The theory rests largely on a two-dimensional analysis; even so, it is only partly developed and the exact effects of the annular phase-contrast rings have not yet been fully explored. During the discussion at the Royal Microscopical Society, Mr. J. R. Smiles, of the National Institute for Medical Research, mentioned difficulties in interpretation of the image due to scattering of light by the object. If the object is an infinitely thin lamina, then the 'scattered' light has the phase characteristics of diffracted light, and consists of the boundary waves, etc., generated in the object plane as well as any light suffering molecular scattering; the effects of this are more or less predictable; the waves are diffracted at the circular aperture of the objective, and the phase-strip contributes

its effect also. The general effect is to form fine halo and shadow fringes near the boundaries of phase-change in the object. Zernike has discussed similar effects in his papers, showing how it is that small opaque particles may sometimes appear bright on a dark ground, drawing their light from neighbouring parts of the field.

But the problem grows much more complex when the object is thicker; the sum of the diffracted light may have no easily predictable phase-relation with the incident light, and could thus be spoken of as 'scattered' in that special sense. The halo and fringe effect may therefore be complex, and although the broader regions of uniform phase should still be rendered at the appropriate brightness levels in the image, we cannot interpret the fringes in the same way in every case. The statement above, that the brightness of the image field is related to the retardation of the object, does not apply to the variations of brightness in the border fringes, and the possibility of estimating the retardation does not apply to relatively small objects.

Enough has been said to indicate that the practical technique must be studied in relation to special objects. The simple theory only takes the worker a part of the way, and there is room for a considerable amount of further work both theoretical and practical. However, all the evidence shows that 'phase-contrast' is a most valuable addition to the methods available to the microscopist, and it is being intensively studied at the present time. One of Zernike's own papers (*Physica*, **9**, 686 and 974; 1942) gives the best starting-point.

MARINE BIOLOGY AT PLYMOUTH*

THE Marine Biological Association of the United Kingdom came into being in 1884 as a result of a meeting held under the chairmanship of Prof. T. H. Huxley, the successive outcome of which owed much to the initiative and energy of Sir E. Ray Lankester. The prime purpose of the Association was "the establishment and maintenance of a well-equipped laboratory at a suitable point on the English coast, similar to, if not quite so extensive as, Dr. Dohrn's Zoological Station at Naples". The suitable point finally selected was Plymouth, and there, under the walls of the Citadel built by Charles II and overlooking the waters of Plymouth Sound, the laboratory building, constructed of the same Devonian coral limestone as the Hoe, was opened on June 30, 1888.

Financial support came initially from members of the Association, from universities and other public bodies, notably the Fishmongers' Company, and from H.M. Treasury. All these sources of income have been maintained and increased, but especially the Treasury grant, which became considerable after 1918, when it was put under the control of the Development Commissioners. In 1902 the Association undertook the British share of the scientific investigations of the International Council for the Exploration of the Sea, which involved the establishment of a second laboratory at Lowestoft for work on the trawling grounds and food fishes of the southern North Sea. After 1918 this laboratory was re-established under the Ministry of Agriculture and Fisheries for work on problems dealing directly with commercial fisheries. The Plymouth Laboratory was to be concerned with the more fundamental problems of marine research, and to this end notable increases were made to the staff, buildings and facilities of the Laboratory in the years between the two World Wars.

The papers published in the *Journal* of the Association, now in its twenty-sixth volume with two earlier volumes in a smaller format, indicate the changing interests and widening scope of the work carried on in the Laboratory. Earlier volumes are largely concerned with observations on the habits of fishes and shellfish and on the methods and results of commercial fisheries. Aided by enthusiastic visiting workers, the basis was also being laid of the extensive knowledge of the marine life of the Plymouth area now recorded in the "Plymouth Marine Fauna" (second edition, 1931). With the assumption of the work for the International Council opportunities came for initial studies on hydrography, on bottom fauna and on plankton. A notable change comes in the subject-matter of the *Journal* after 1918, with emphasis on the study of the chemical and physical conditions of the environment, on the life-histories and development of marine invertebrates and on the distribution in space and time of the animal populations. Nevertheless, research on the biology of fishes continued and provided a necessary link with the more economic investigations being carried out at Lowestoft. But recognition of the value of fundamental research had been achieved. To-day we are approaching the stage when all fisheries research will become increasingly fundamental, aimed at understanding the great natural fluctuations in the fish populations and the causes of the habits of the fish themselves.

The Plymouth Laboratory has provided the basis for such far-reaching studies by the concentration of its work around two main themes. The first is how much living matter can the sea produce, what are the variations and causes of variation in productivity, and how do the organisms obtain the materials necessary for life? The second is how do marine animals live, how do they fit their various environments, and what alterations in the conditions in their environment can they appreciate? The sea water contains all the ingredients needed for successful growth and development of living organisms; it is the conditions in the water which therefore determine their distribution and migrations.

The study of the physics and chemistry of the sea has thus become a major preoccupation. The approximate yearly cycle of the more abundant constituents —phosphorus, nitrogen and silicon—is now known, although much remains to be done on the annual turnover and on periodic fluctuations. This in turn involves a study of water movements, especially of upwelling from deep layers. Plant life depends on light and is limited by the depth of its penetration; this is being studied by methods employing photo-electric cells. Meanwhile, pure cultures of diatoms and flagellates are used as experimental material for determining the utilization of combined nitrogen and phosphorus, and the effect of trace elements such as iron and manganese, which may limit plant production in the sea.

Animal plankton forms the first link of the chain from plant plankton to fish, and researches on its distribution, abundance, growth and habits form a necessary part of the study of the general problem of productivity. The effects of grazing off the plant

* Substance of a lecture by Wing-Commander F. S. Russell, F.R.S., delivered at the Royal Society on March 6.

crops can be studied at sea by evaluation of their numbers in measured volumes of water and also experimentally in the laboratory. Certain species of plankton organisms are restricted to certain types of water, and form most valuable biological indicators of their respective water masses, which are often not easily distinguishable by the usual hydrological features, such as salinity and temperature.

Bottom-living invertebrates form the food of many fish and are specialized for life in different grades of bottom material, from fine mud to coarse gravel, and normal metamorphosis from the larval stage may only occur on the appropriate substratum. Study of the available food in the different deposits reveals considerable variations. The topography of the sea bottom is also important in connexion with water movements. There are indications that the embayments resulting from submerged valleys may cause submarine waves, with consequent upwelling of nutrient-laden water into the photic layers.

With the exception of insects, all the major groups of animals are represented, many of them exclusively, in the sea. The problems they present for inquiry to the systematist, morphologist, ecologist, parasitologist, embryologist and geneticist are without limit, and so, from this point of view, are the facilities of the Plymouth Laboratory. From a study of structure there is a natural transition to that of life-histories, food and feeding, breeding and growth, and the general relationships between the animal and the environment. Apart from the bearing of such studies on food fishes and shellfish, they provide essential knowledge for combating the activities of marine boring animals and of fouling organisms. During the War the demand for raw material, such as alginic acid, agar and mannitol, from seaweeds, gave a sudden stimulus to research on the life-history and growth-rate of intertidal weeds, of which very little was known. Extension of work into estuarine waters has provided physiological problems of the first importance and data of value in assessing pollution. Finally, by the working out of new methods of collection and analysis, the Laboratory has played an important part in the success of deep-sea expeditions carried out by vessels of many countries.

While the work of the staff at Plymouth is most varied, as revealed in the foregoing brief survey, it is greatly increased by that of the continuous stream of visiting workers from all countries which has always been encouraged in every way possible. To them in particular has been due the increasing volume of physiological work for which the rich supply of animal life provides material often unobtainable elsewhere, such as the spider crab, *Maia*, used for nerve physiology and studies on the respiratory pigment, hæmocyanin, the squids and cuttlefish with their giant nerve fibres, sea anemones with their simple nerve net, and the dogfish which has provided material for elucidation of the function of the lateral line and of the labyrinth.

From the simple beginnings of accommodation, staff and programme in 1888, the Plymouth Laboratory has been gradually raised to its present commanding position among research institutions, above all by the careful guidance of Dr. E. J. Allen, its director for forty-two years, and of his successor for an all too brief period, Dr. Stanley Kemp. With their names will always be associated that of Dr. G. P. Bidder, who has given so generously in wisdom and money. The present buildings can accommodate some forty workers, including the present twelve members of the permanent staff. It possesses an admirable library and an aquarium. There are two research vessels, a 25-ft. motor boat and a 90-ft. motor fishing vessel used for investigations at sea and also for collection of specimens and for stocking the aquarium. During the Easter vacation, they also assist in the courses for students which are so important a feature in the work of the Laboratory, and which have guided many young zoologists into a life-work of fruitful research either in the universities or in marine laboratories.

The Plymouth Laboratory, in the words of its present director, F. S. Russell, "aims to give facilities for any research, not necessarily only biological, on problems for which the sea can provide the materials or the environment required. Its position is unique, lying as it does between the extremes of a fishery research laboratory and of an oceanographical institution, yet serving both, and at the same time offering facilities for visitors like the laboratory at Naples on whose pattern it was first founded. Let us hope it may continue to hold this focal position and attract all those interested in the science of the sea and indeed of life itself."

THE VIENNA ACADEMY OF SCIENCES (1847–1947)

THE "Kaiserliche Akademie der Wissenschaften" of Vienna was founded by Kaiser Ferdinand I on May 14, 1847. Although not a State institution, the Academy is conducted under the ægis of, and is endowed by, the State. It consists of two Sections (Klassen), the Mathematical and Natural Science Section for mathematics, natural science, medicine and technical science, and the Philosophical and Historical Section for philosophy, history and archæology, art and music, language and literature, geography and ethnology, law, political science and economics. The Sections meet separately every fortnight for the consideration and discussion of scientific subjects, and they have a joint session once a month.

The work of the Academy is carried out under the continuous supervision of a commission for each scientific subject or for a particular research undertaking, this commission advising on the equipment, methods and problems of the undertaking, and on the choice of suitable personnel. From the scientific point of view, the main work of the Academy is under the care of its members, and it maintains a scientific liaison with various State institutes, in particular with those of the University of Vienna. Moreover, the Academy has several institutes under its direction, especially on the scientific side.

Each Section of the Academy has 33 members and 80 corresponding members, of whom 35 are Austrians and 45 foreign nationals, and there are also 8 honorary members in each Section. Provision is also made for the election of eight honorary members of the whole Academy, and these would be mostly highly placed dignitaries of the State who have rendered service to research or to the advancement of the interests of the Academy, or distinguished men of learning of national or international repute. Corresponding members are entitled to take part in open meetings of the Sections, but they are not automatically promoted to full membership of the Academy. Places rendered vacant by the death of members or corresponding members

are filled at the annual elections, and membership is only possible by election.

During the past hundred years, the activities of the Academy have been many and varied. In the Mathematical and Natural Science Section, a beginning was made in 1849 with meteorological observations in Austria, and these laid the foundation for the establishment of the Zentralanstalt für Meteorologie und Geodynamik, now a State institution, but with which the Academy still maintains close scientific connexion. Measurements of gravity in Austria in relation to geotectonic structure have been carried out, a magnetic survey of the country has been made, and investigations on atmospheric electricity have been undertaken. Furthermore, the Academy has taken part in Polar expeditions and fitted out the station on Jan Mayen Island (off Greenland) in the years 1882–83 and 1932–33. In the years 1867–79 investigations of a hydrographic and physical nature were carried out in the Adriatic, and during 1890–98 expeditions were sent to the Eastern Mediterranean (north of Crete), to the Sea of Marmora and to the Red Sea for hydrographic and geophysical observations, for the chemical and physical investigations of the water, and for the collection of zoological specimens. In 1901 a botanical expedition was sent to Brazil, and one for zoology in 1903.

On the scientific side, the Academy administers wholly or in part a number of research institutions. The Institut für Radiumforschung (Vienna Radium Institute) was founded in 1910 and possesses 4 gm. of radium chloride for research purposes. From among its past activities may be mentioned the provision and certification (jointly with Paris) of radium standards, the development of methods of measurement, investigation of the various radioactive radiations and the effects of radioactive substances, the isolation and properties of the radio-elements, and work on isotopy. The years between the two World Wars were characterized primarily by K. Przibram's work on crystal physics, and a large amount of work was done in the Institute on problems connected with artificial transmutation (by Pettersson, Kirsch, Ortner, Stetter, Blau and others). At the Biologische Versuchsanstalt in Wien (Prater), experimental zoological and botanical work was carried out between 1913 and 1941, more especially on *Entwicklungsmechanik* and research on regeneration. The Station was damaged during the War, and its director and co-founder, Hans Przibram, was a war victim and died in a concentration camp. The Biologische Station in Lunz investigates the plant and animal world from the point of view of biology and ecology in the three Alpine lakes and in the neighbourhood accessible from the Station. The Academy also has Höhenobservatorien (mountain observatories) on the Sonnblick (Hohe Tauern, 3,100 m.), and on the Obir (2,000 m.) in the Karawanken, south-east of Klagenfurt.

The Philosophical and Historical Section of the Academy has conducted research in the field of Austrian history back to prehistoric times. It has carried out prehistoric excavations and investigations on monuments from Roman times, and has published "Quellen zur österreichischen Geschichte" (Sources of Austrian History) dating back to the early Middle Ages. Between 1900 and 1910 research expeditions were sent to Southern Arabia for linguistic purposes, and likewise to Palestine and Transjordan for archæological studies. It has also published a *corpus* of ecclesiastical writers in Latin, as well as records of Greek and Roman inscriptions of Asia Minor resulting from journeys of exploration in that region. Furthermore, excavation of an extensive cemetery near Giza, in the neighbourhood of the Great Pyramids, yielded important results on the history of architecture and sculpture of the Old Kingdom in Egypt. Linguistic and archæological investigations in the Balkans have have also been undertaken.

Among the institutes under the control of the Academy there is also a Phonogrammarchiv (Gramophone Library), equipped with the most modern methods of recording, and here are housed a large number of speech records of most of the world's living languages, vocal 'portraits' of important historical Austrian personages and representatives of the stage, together with interesting medical records on rare defects in speech.

In the realm of natural science, the Academy has the names of many distinguished men of science on its roll, including the mathematician Wilhelm Wirtinger, the physicists Loschmidt, Boltzmann, Franz Exner, Ernst Mach and Stefan, the chemist Auer von Welsbach, the geologist Eduard Suess, the botanists Richard Wettstein and Hans Molisch, and the medical scientists Karl Rokitansky (pathological anatomist), Sigmund Exner (physiologist) and Theodor Billroth (surgeon).

The Academy issues the following publications: *Denkschriften der Gesamtakademie* (Vol. I: History of the Academy, 1847–1947, by the present vice-president, Prof. R. Meister), *Almanach* (annual reports of the Academy), *Anzeiger* (preliminary notices) of the two Sections (annual reports of activities). Scientific papers in each Section are published in *Denkschriften* and in the *Sitzungsberichte*.

It is not generally known that the Vienna Academy rendered incalculable service in two directions in the early days of radioactivity. When it was realized that there were other radioactive substances than uranium and thorium present in pitchblende, it seemed probable that these would be found in the uranium residues resulting from the extraction of uranium, of which large quantities lay derelict at St. Joachimstal in Bohemia. The French approached Suess, who was president of the Academy at the time, and through his intervention with the Ministry of Agriculture, two wagon loads of the residues were dispatched free of charge to Paris. It was from this material that the Curies isolated the element radium and prepared the Primary International Radium Standard, and it has been estimated that 60,000 kgm. of these residues contained a total of about 24 grams of radium. The second instance concerns the loan by the Academy of about 400 milligrams of radium to the late Lord Rutherford; it was primarily with this material that most of the work of the Rutherford Schools at Manchester and Cambridge was carried out. After the First World War, Lord Rutherford purchased this radium from the Academy in annual instalments, and as a direct result the Vienna Radium Institute was enabled to carry on through the first lean years of peace.

On the recommendation of Prof. H. Mache, of the Technical High School, it was my happy privilege to work in the Vienna Radium Institute during 1913–19. That grand old man of science, the spectroscopist Franz Exner, lovingly known as 'Väterchen', was the representative of the Academy in the Institute, and Stefan Meyer made an ideal director. It is good to know that, after a break of several years, he is again

directing the Institute, and that Karl Przibram is also there. Imbued with the spirit of the Exner School, Meyer was ever ready to place at the disposal of his fellow-workers his stimulating ideas and great wealth of experience as a pioneer and fruitful worker in the field of radioactivity. At the outbreak of war in 1914, and with the backing of the Academy, he successfully appealed for my release as a civilian prisoner of war, and as a result my work in the happy family atmosphere of the Institute continued throughout hostilities. During these years much of the pioneer work on isotopy and on tracer elements (radioactive indicators) was carried out in the Institute (Hevesy and Paneth), and the atomic weights of lead of radioactive origin and of other radioactive elements were accurately determined by Hönigschmid. Several Polish refugees worked in the Institute at that time, including Godlewski, Loria and Patkowski. Work on the counting of radioactive rays was actively pursued, mainly in collaboration with the chief assistant, V. F. Hess, discoverer of cosmic rays (1912). It is of interest to note that two of the members of the Institute later received the Nobel Prize (Hess and Hevesy), the latter also being elected a foreign member of the Royal Society, and quite recently Paneth (now at Durham) has been elected to fellowship of the Society. I shall be ever grateful for the friendly and cordial way in which I was received into the fellowship of the Radium Institute of the Academy, the stimulating and fertile influence of whose members was alone responsible for my being able, as an enemy alien in those eventful years, to publish twenty-three scientific papers, sixteen of which were presented to, and accepted without hesitation by, the Academy for publication in the *Berichte*.

I have much pleasure in acknowledging the help given me by the vice-president of the Academy, Prof. R. Meister, who supplied much of the information contained in this article. I am also indebted to Akademierat Dr. W. Oberhummer and to my old friend Hofrat Prof. H. Mache for additional information.

ROBERT W. LAWSON

CENTENARY CELEBRATIONS

The centenary of the Academy was celebrated in Vienna during the week beginning May 11. After the reception of guests in the Academy on the previous evening, the proceedings began on Monday, May 12, with a meeting of the Historical and Philosophical Section. The meeting was opened by the vice-president, Prof. Richard Meister, and after submitting the report of the Section, the general secretary, Prof. Josef Keil, described the work of the Austrian Archæological and Philological Expedition to the Balkans, Asia Minor, Arabia and Egypt. In the evening, there was a performance of Hoffmansthal's "Jedermann" given in the Ronacher Theatre, since the Burgtheater had been damaged by bombing. The meeting of the Mathematical and Science Section was opened on the following day by the president, Prof. Heinrich Ficker, and after the report had been presented by the secretary, Prof. Adalbert Prey, a historical account of the meteorological and geophysical work of the Academy was given by Prof. Ficker.

On May 14 the main ceremonial meeting was held in the great hall of the Academy. The ceiling, which had been damaged by water, has been restored, and this hall, with its magnificent baroque interior, made a fine setting for the distinguished gathering. The president of the Academy, in opening the ceremony and in welcoming the guests, pointed out that the Academy, which once belonged to a great country, now belongs to a small one, but that he hoped it would maintain, on the intellectual level, the characteristics of a great country. The President of Austria, Dr. Karl Renner, who had recently been elected an honorary member, then addressed the meeting, and stressed the importance of the freedom of science and research, and its independence from political influence or ideas. The Austrian Chancellor, Dr. Leopold Figl, then spoke. He referred to the role of Austria in the past as a mediating influence between East and West, and hoped that, in the present times, this could be taken up again. After a speech by the Minister of Education, Dr. Felix Hurdes, the congratulatory addresses from foreign societies were presented. In spite of the difficulties of travel, a number of learned societies sent delegates to attend in person: these included the British Academy (Sir Charles Webster); Royal Academy of Brussels (Prof. Henry Gregoire); Cambridge Philosophical Society (Dr. F. P. Bowden); Czech Academy of Sciences (Dr. Viktor Trkal); Papal Academy of Sciences, Rome (Prof. Ernst F. Petritsch); Paris Academy of Sciences (Prof. Charles Jacob); Polish Academy of Sciences (Prof. Tadeusz Kowalski); Swedish Royal Academy of Sciences (Dr. Orvar Nybelin); Swedish Royal Scientific Society (Prof. Einar Löfstedt); Swiss Academy (Prof. A. von Muralt); and Hungarian Academy of Sciences (Prof. S. Domanovsky). Congratulatory addresses and telegrams were also received from learned societies throughout the world.

The president then announced the election of new members and the award of prizes. Dr. Karl Renner was elected the sole honorary member of the whole Academy. Of the Mathematical and Science Section, J. Radon and W. Schwarzacher were elected full members; E. Hubble and P. Niggli, foreign honorary members; Sir Henry Dale, A. Ernst, O. Hahn, E. Hertzsprung, H. Pettersson and F. Vening-Meinesz, foreign corresponding members. Of the Philosophical and Historical Section, R. Köstler and K. Mras were elected full members; A. Dempf, I. P. Dengel and C. Rauch, Austrian corresponding members; P. F. Jouguet and Gilbert Murray, foreign honorary members; and C. Borren, B. Croce, S. Eitrem, H. Kelsen, G. Mercati and C. Samaran, foreign corresponding members. The Grillparzer Prize was awarded to Rudolf Holzer; the Fritz Pregl Prize to Heinz Holter; the Haitinger Prize to Prof. Berta Karlik, who worked for a time at the Royal Institution, London; and the Rudolf Wegscheider Prize to Prof. Alfons Klemenc. The meeting closed with an account, given by the vice-president, Prof. Meister, of the history of the Academy during the hundred years of its existence; the first award of the Jubilee Prize was made to him for his "Geschichte der Akademie der Wissenschaften in Wien, 1847–1947".

In the evening, there was a special performance by the State Opera Company of "Figaro", given in the Redoutensaal of the Hofburg. It was a remarkable performance, sparkling with life and gaiety, and it seemed typical of the gay courage of the Viennese and Austrian people that such an art could flourish in spite of the present hardships and the distress and misery of the past few years. On May 15 there was an excursion to the Benedictine Monastery at Melk, and to the Biological Station at Lunz. The Station is beautifully situated near the lake in the hills, and

the surrounding fields were thick with wild narcissi and spring flowers. On the last day there was a visit to the National Library, followed by a lunch on the Kahlenberg, given by the Mayor of Vienna, and a farewell gathering in the evening in the Rathauskeller.

The visiting delegates naturally found great pleasure in establishing once more normal human relationship with their colleagues, and took the opportunity of visiting their laboratories. Even in the buildings which have not been damaged, the difficulties of carrying on with work are considerable. The problem of fuel for heating the buildings and laboratories throughout the severe Viennese winter is a serious one. Last winter, for example, in the physical and chemical laboratories, no fuel was available; and unless some can be obtained for the coming winter, much of the practical teaching and of the research work must again come to a standstill. No apparatus can be obtained to replace that which has been destroyed or stolen, and the lack of chemicals and the impossibility of getting any is a severe handicap both to teaching and to research. In all departments, the inability to get current publications or books from other countries is considered to be one of the most urgent problems. Action on this is being taken by the British Council and other bodies, but this necessarily takes time, and at the moment there is very little scientific literature available. It was impressive to see how the pursuit of knowledge and the arts, and interest in things of the spirit, took precedence over the material discomfort and struggle of living.

The celebrations were an unqualified success, and, considering the grave material difficulties, it was a remarkable achievement on the part of the secretaries of the Academy and the organisers. There is no doubt that the success owed much to the genial and commanding personality of the president, Prof. Ficker.

F. P. Bowden

OBITUARIES

Prof. H. S. Jennings

The death of Prof. H. S. Jennings, just after his seventy-ninth birthday, at Santa Monica, California, on April 14, has removed the most venerable figure from the ranks of students of the physiology and genetics of the Protozoa. His passing marks the end of an epoch.

Herbert Spencer Jennings, son of George Nelson Jennings, was born at Tonica (Illinois) on April 8, 1868. He graduated B.S. at Michigan in 1893, and afterwards held several different posts in other American universities. He took the degrees of A.M. (1895) and Ph.D. (1896) at Harvard, and after further wanderings settled at Johns Hopkins. Here he was appointed professor of experimental zoology in 1907, and became director of the zoological laboratory three years later (1910). He occupied this position with distinction until his retirement as professor emeritus in 1938, when he went to prolong his life's work—as a 'research associate'—at the University of California at Los Angeles. His name is therefore especially linked with Johns Hopkins, though he worked in many other places and received degrees and honours from many other American universities. His first wife—he married twice—was Louise Burridge, who assisted in the illustration of his publications.

During 1896–97 Jennings studied at Jena under Max Verworn, whose "Allgemeine Physiologie" (first published in 1894) was then arousing much interest among zoologists. Verworn was a pupil of Haeckel, and his book was not inaptly labelled by Rádl "the first—and probably also the last—Darwinistic physiology". Yet there can be little doubt that Jennings's brief residence in the stronghold of Haeckelism favourably influenced all his subsequent researches. After numerous preliminary papers he finally produced—while at Philadelphia—his famous "Behavior of the Lower Organisms" in 1906; and this is now generally accepted as a classic of protozoological physiology.

His studies on the physiology of *Paramecium* gradually led Jennings to investigate variation and heredity in this and other ciliates. A long series of papers—from 1907 until the end of his life—records the results of his accurate and admirable experiments. It is impossible to review these here, but most of his general conclusions will be found in his book "Life and Death, Heredity and Evolution in Unicellular Organisms" (Boston, 1920), his review "Genetics of the Protozoa" (*Bibl. Genet.*, vol. 5, 1929), and the article on "Inheritance in Protozoa" which he contributed to "Protozoa in Biological Research" (edited by Calkins and Summers, 1941; reviewed in *Nature*, vol. 149, p. 149; 1942).

Jennings's own labour, and that of his many pupils in similar fields, covered a restricted area but dug very deeply. It is still doubtful, however, how far their findings, in the intensive study of such highly specialized and peculiar organisms as the Ciliata, can be utilized for generalization in the larger domain of genetics. But taken as a whole, the extensive published work of H. S. Jennings does not belie the promise in his forenames: it is all distinguished by a sound philosophical outlook and profound appreciation of the value and scope of scientific method. Consequently, much that he did and wrote will withstand the test of time; and though all his conclusions may not ultimately prove correct, his experiments and his reasonings will undoubtedly endure as a solid basis for the researches of a newer generation.

Clifford Dobell

Mr. G. H. Tipper

George Howlett Tipper was born in Kendal in 1881, and educated at Kendal Grammar School and Clare College, Cambridge. He entered the Geological Survey of India in 1902. Apart from service in many parts of India, he went to Burma, the Andaman and Nicobar Islands; he travelled through Baluchistan and across Persia and spent three years in Chitral. During the First World War he served with the Bikanir Camel Corps in Egypt and the Libyan Desert and was in France for a short time. He was eventually recalled to help with the production of mica, a mineral in which he had already specialized. From this time he became keenly interested in its mining and preparation for industry, working at the mines themselves and even learning the technique of trimming and splitting.

Tipper had several severe attacks of malaria while abroad and retired after twenty-five years service in 1927. After visiting mica mines in Rumania and a period of travel in Canada and the United States, he married Dr. C. F. Elam, the well-known metallurgist, and retired to Cambridge with the view of working

on the fossils he had collected in Chitral. However, he was soon invited to act as a minerals adviser to the High Commissioner for India, where his wide experience and exceptional memory were invaluable.

At the outbreak of war in 1939, Tipper went for a short time to the Department of Economic Warfare and thence to the Ministry of Supply as 'the acknowledged expert of experts' on mica. In 1941 he went as a representative of Great Britain and the Government of India to the United States to help in the organisation of supplies of mica on both sides of the Atlantic, and was attached to the British Raw Materials Mission in Washington. Altogether, he made the double crossing of the Atlantic four times during the War; he flew to India via New Zealand and Australia and also to Brazil. This last trip was a particularly arduous one. On his return to Great Britain, he continued at the Mica Control and eventually became director, until he was compelled to resign on account of ill-health in October 1946. His services were so much valued by the Board of Trade that he was retained as a consultant until his death on April 23, 1947.

Tipper combined the rare qualities of the trained geologist with an intimate acquaintance of the mica trade in all its aspects; but he could not have carried out his war-time work with such success if his complete honesty had not made him trusted and liked by everyone. His devotion to his work compelled him to embark on a series of journeys which many a younger man would have found exhausting, and kept him at work when he was already in bad health. One of his colleagues writes: "I don't suppose that the State ever received more selfless service from a man of great ability than England got from him".

Dr. Leopold von Portheim

THE botanist, Dr. Leopold von Portheim, died in London on May 21. He had been seriously ill for some time. Portheim was born in Prague on February 7, 1869, and studied botany there and at Vienna, where he was a pupil of Dr. Julius von Wiesner. He thus lived to be one of the last surviving botanists who were trained by this great master.

One of the most notable achievements in which Portheim took a leading part was the foundation of the Biologische Versuchsanstalt in Vienna in 1901. In this he was associated with Prof. Hans Przibram and Prof. Wilhelm Figdor. The Institute founded by these biologists later became an important centre for research into the physiology of plants and animals. After the First World War the laboratory was presented to the Academy of Sciences in Vienna, Portheim being director of the department of botany. The Institute was destroyed during the Second World War.

When Austria fell under Nazi domination, Portheim's botanical career in that country came to an untimely end, for he was forced to leave the institute which he himself had helped to found, and he fled from the country. Arriving in Great Britain in December 1938 with a note of introduction from the famous Swiss botanist, Carl Schröter of Zurich, he was given hospitality at the Jodrell Laboratory at the Royal Botanic Gardens, Kew, by the late Sir Arthur W. Hill, who was then director of the Gardens. He continued to work at Kew until afflicted with the illness from which he died.

Although his work is not very familiar to British workers, Portheim published papers dealing with plant physiology and related subjects. During the First World War his investigations were concerned especially with the production of fats by some of the lower fungi. He also studied the influence of light on the growth of plants, and later became interested in the action of plant growth substances. The researches on heteroauxin which he started in Vienna were continued at Kew, where he also performed the remarkable achievement of keeping various members of the xerophytic Cactaceæ alive, and caused them to flower in jars of tap water during a period of about five years. He also did some experimental work on antibiotic substances. During his time at Kew he was severely handicapped by poor eyesight, which made it impossible for him to use a microscope. Nevertheless, the extreme care and patience with which he followed his experiments were most praiseworthy, while his attention to detail was such that not even the most trivial facts escaped his notice.

Portheim, who travelled extensively in Europe and also visited the United States, was a man of great personal charm and kindliness, while he was endowed with a keen sense of humour. His extreme modesty and retiring disposition undoubtedly led many to under-estimate his wide knowledge of the physiology of plants. Those who were privileged to know him more intimately found him to have a wide and cultured outlook and to be a firm friend. He will for long be remembered by all who worked at the Jodrell Laboratory while he was there. He leaves a widow and married daughter. C. R. METCALFE

Prof. J. Veliśek

BY the death of Dr. Joseph Velíšek, professor of physical chemistry at Brno Technical College, on February 2, Czechoslovakia is deprived of another comparatively young and energetic teacher and investigator. Velíšek was only fifty years of age and had not long succeeded Prof. Baborovský, whose assistant he had been for many years. In 1922–23 Velíšek, under Jorissen at Leyden in Holland, investigated the influence of the vapours of non-inflammable liquids on the explosion limits of methane–air mixtures. His other scientific work included a special study of the hydration of lithium ions, the electro-osmosis of alkali chlorides and other salts through porcelain diaphragms, the use of calcium for electrodes and an examination of the 'turbulent' or 'hydraulic' flow of liquids. Prof. Velíšek was a keen amateur cinematographer. J. G. F. DRUCE

WE regret to announce the following deaths:

Mr. B. Hilton Barrett, lecturer in geology in the University of Glasgow for nearly thirty years, on June 9.

Dr. D. E. Lea, reader in radiobiology in the University of Cambridge, on June 16, aged thirty-seven.

Prof. Philip W. Schutz, professor of chemical engineering in the University of California, known for his work in chemical engineering thermodynamics and dielectric heating, on March 7, aged thirty-eight.

Prof. A. F. Bernard Shaw, professor of pathology in the University of Durham, and during 1933–38 professor of pathology in the Egyptian University, Cairo, on June 3, aged fifty-eight.

NEWS and VIEWS

King's Birthday Honours List

THE following names of scientific men and others associated with scientific work appear in the King's Birthday Honours List:

Baron: Sir Roy Lister Robinson, chairman of the Forestry Commission.

C.H.: J. W. Robertson Scott, author, founder and until recently editor of *The Countryman*.

D.B.E.: Miss Caroline Haslett, for services to the Board of Trade and Ministry of Labour.

Knights: Dr. William Norwood East, for services to the study of criminal psychology; R. R. Enfield, chief economic adviser, Ministry of Agriculture and Fisheries; Prof. D. D. Henderson, professor of psychiatry, University of Edinburgh; Prof. E. L. Kennaway, lately director of the Chester Beatty Research Institute, Royal Cancer Hospital, London; Dr. A. McCance, deputy chairman and joint managing director of Messrs. Colville's, Ltd., Glasgow, a member of the Advisory Council to the Committee of Privy Council for Scientific and Industrial Research; Prof. A. Plant, Sir Ernest Cassel professor of commerce with special relation to business administration at the London School of Economics and Political Science, for services to Government Departments.

C.B.: Dr. E. T. Paris, principal director of scientific research (defence), Ministry of Supply.

C.S.I.: J. P. Mills, adviser to the Governor for Tribal Areas and States, Shillong, Assam; V. K. Maitland, chief conservator of forests, Central Provinces and Berar.

C.M.G.: R. W. Thornton, agricultural adviser to the High Commissioner for Basuto, the Bechuanaland Protectorate and Swaziland, and director of the Native Land Settlement Department, Swaziland; R. Watson, director of agriculture, Burma.

C.I.E.: W. G. Dyson, chief conservator of forests, Madras.

C.B.E.: J. E. C. Bailey, managing director of Baird and Tatlock, Ltd.; G. L. Brown, of the National Institute for Medical Research, London, for services to medical research in the Royal Navy; O. F. Brown, assistant secretary, Department of Scientific and Industrial Research; N. S. Clouston, lately commissioner of lands and director of surveys, Nigeria; R. R. Glanville, director of agriculture, Sierra Leone; J. H. Gunlake, lately assistant statistical adviser, Ministry of Transport; Dr. J. A. Gunn, director of the Nuffield Institute for Medical Research, University of Oxford, and chairman of the British Pharmacopœia Revision Committee; H. L. Kirke, head of the Research Department, B.B.C.; Prof. T. D. J. Leech, dean of the Faculty of Engineering, Auckland University College; J. R. Lumsden, chairman of directors, Highland and Agricultural Society of Scotland; Prof. J. A. Prescott, director of the Waite Agricultural Research Institute and chief of the Division of Soils, Council for Scientific and Industrial Research, Australia; F. A. Secrett, technical adviser on vegetable production, Ministry of Agriculture; J. M. Wordie, for services to exploration in the Antarctic.

Jacksonian Professorship at Cambridge: Dr. O. R. Frisch, O.B.E.

DR. O. R. FRISCH has been appointed to the Jacksonian professorship of natural philosophy in the University of Cambridge in succession to Dr. J. D. Cockcroft. Dr. Frisch was born in 1904 in Vienna and was educated at the University of Vienna during 1922–26. He worked on photometry and interferometry at the Physikalisch Technische Reichsanstalt in Berlin between 1927 and 1930. He then took up work with Prof. Otto Stern on experiments with molecular beams. With Stern he determined by this method the magnetic moment of the proton and studied the diffraction of helium atomic beams by crystal faces. During 1933–34 he worked for a year with Prof. P. M. S. Blackett, and then for five years with Prof. Niels Bohr at Copenhagen. With L. Meitner he was the first to demonstrate by experiment in an ion chamber the physical nature of nuclear fission. He went to Birmingham in 1939. In the spring of 1940, with Prof. R. E. Peierls, he worked out the possibility of producing an atomic bomb by the fission of U235, and thereafter worked on this project for the British Government. In 1943 he proceeded to Los Alamos as part of the British team working with the U.S. Atomic Energy Project, and carried out important experimental work on the atomic bomb. For this work he was awarded the O.B.E. in 1946 and the Medal of Freedom with Bronze Palm (U.S.) in May 1947. Dr. Frisch has been deputy chief scientific officer in charge of nuclear physics at Harwell since 1946. By his election to the Jacksonian professorship, the Cambridge school of nuclear physics is assured of distinguished leadership.

Physics at St. Andrews: Prof. J. F. Allen

THE vacancy in the chair of natural philosophy in the United College, St. Andrews, due to the acceptance last year by Prof. J. T. Randall of the Wheatstone chair of experimental physics at King's College, London, has now been filled by the election of Dr. J. F. Allen, of St. John's College, Cambridge, to the post. Dr. Allen is a graduate of the Universities of Manitoba, Toronto and Cambridge, and has been a research assistant in the Royal Society Mond Laboratory, Cambridge, where he conducted research on liquid helium and on magnetic cooling. During the war years he was engaged in work on behalf of the Ministry of Aircraft Production and the Ministry of Supply. It is anticipated that he will continue low-temperature research in a new laboratory to be built at St. Andrews.

Royal Aeronautical Society: Dr. H. Roxbee Cox

DR. H. ROXBEE COX has been elected president of the Royal Aeronautical Society for 1947–48, and takes office on October 1, 1947. Dr. Roxbee Cox, who was born in 1902, obtained first-class honours in engineering and took an advanced course in aeronautics at the Imperial College of Science and Technology, London. In 1924 he joined the Royal Airship Works. Four years later he was awarded the R.38 Memorial Prize of the Society for his paper on "The External Loads on an Airship Structure". Following the Government decision to discontinue airship work, Dr. Roxbee Cox returned to the Royal Aircraft Establishment, renewing his work on wing flutter, aircraft structures and aerodynamics, and in 1936 became head of the Air Defence Department at the Establishment. In 1938 he was appointed chief technical officer to the Air Registration Board, and on the outbreak of war seconded as superintendent of scientific research at the Royal Aircraft Establishment. In 1940 he became deputy director

of scientific research in the Air Ministry, paying special attention to jet propulsion gas turbines; at the Ministry of Aircraft Production as director of special projects he became closely associated with all British gas turbine work. In 1944 Dr. Roxbee Cox became chairman and managing director of Power Jets (Research and Development), Ltd., and when it became a Government establishment under the title of the National Gas Turbine Establishment he was appointed director. In 1940 he delivered the Wilbur Wright Memorial Lecture of the Royal Aeronautical Society, speaking on civil aviation, and in 1945 the Wright Brothers Memorial Lecture of the Institute of the Aeronautical Sciences on gas turbines. Last May he was honoured by the Universities of Brussels and Louvain and the Faculté Polytechnique de Hainaut at Mons. At Louvain Dr. Roxbee Cox was presented with the Memorial Medal of the University, and at Mons he was made an honorary member (of whom only five people have been so honoured) of the Association des Ingenieurs de la Faculté Polytechnique de Mons.

Emergency Committee of Atomic Scientists

"A NEW type of thinking is essential if man is to survive and move to higher levels." These words are quoted from a statement made last summer by Prof. Albert Einstein with which he designed to shock the world out of its complacency. Together with other prominent American men of science he expressed great concern at the use to which mankind would put atomic energy. He recognized that the problem, as Mr. Baruch has so wisely put it, is not one of physics but of ethics, and it is his belief that the only security and hope for mankind lies in a public educated to understand the simple facts concerning atomic energy and their implications for society, for an informed public will surely act for life and not for death.

A million dollars is needed for this great educational task. To collect this money, and to use it in an educational campaign to ensure that atomic energy will be used for the benefit of mankind and not for humanity's destruction, the Emergency Committee of Atomic Scientists, Incorporated, with headquarters at Princeton, New Jersey (Room 28, 90 Nassau Street), has been formed. The trustees are Albert Einstein (*chairman*), H. C. Urey (*vice-chairman*), H. A. Bethe, T. R. Hogness, P. M. Morse, L. Pauling, L. Szilard and V. F. Weisskopf. The Committee's programme, as outlined in communications recently received from Prof. Einstein, is to see that the following simple facts, which are accepted by all scientific workers, are given the widest possible publicity. They are: (1) that atomic bombs can now be made cheaply and in quantity, with future bombs likely to be even more powerful and destructive; (2) that there is no military defence against atomic bombs; (3) that other nations can discover for themselves the processes kept secret by the United States; (4) that preparedness against atomic warfare is futile and, if attempted, will ruin the structure of social order; (5) that if war does occur, atomic bombs will definitely be used, and will surely destroy our civilization; and (6) that international control of atomic energy and, ultimately, the elimination of war, is the only solution to the problem.

The Emergency Committee does not propose to make governmental policy, either at the national or international level, but intends to work through all appropriate educational organisations, including associations such as the Federation of American Scientists, into which, it will be recalled, most of the American organisations of scientific workers, which sprang into being spontaneously with the dropping of the atomic bomb on Hiroshima and the purpose of which was the study and promotion of atomic energy control, have since been united. The Federation, some time ago, set up a Committee for Foreign Correspondence (Box 615, Berkeley, California) to distribute literature on problems of atomic energy control throughout the world. With financial assistance recently received from the Einstein Emergency Committee, the Foreign Correspondence Committee has now been enabled to widen its activities very considerably. Letters, in a variety of languages, are being sent to scientific and social organisations, libraries, student groups, etc., and also to individuals in more than sixty different countries, in order to keep the public informed of developments in the United States; to develop an important medium for analysing mutual problems; to convince others of the sincerity of American men of science; and to create sufficient confidence, through friendly contact and understanding, to permit the operation of an international system of atomic control which is one of the keystones of the establishment of world peace.

Mutations Induced by Irradiation of the Substrate

W. S. STONE, O. Wyss and F. Haas (*Proc. U.S. Nat. Acad. Sci.*, **33**, 59; 1947) have discovered that mutations of *Staphylococcus aureus* may be induced by irradiating the medium with ultra-violet light before inoculation. Even a delay of 30 hours between irradiation and inoculation gave positive results. If the Fildes synthetic medium is irradiated, no growth takes place; this was later shown to result from toxic products of radiated glucose. Irradiation of the mineral salts of this medium gave no positive results, but irradiation of the vitamins and amino-acid fractions resulted in a marked increase of the mutation-rate. For example, penicillin-resistant mutants (in the irradiated series) ranged from six to a hundred times as many as in the controls; for resistance to streptomycin there was a similar increase of mutants. It was shown that these mutants were distinct and genetically controlled. Preliminary experiments indicate that it might be possible to induce an increase of a particular gene mutant without affecting others. The activation of the chemicals of the medium may be due to some mechanism involving a shift to a higher energy-level by the absorption of a quantum of energy during irradiation, or a definite change in the chemicals concerned. The substance created is called an 'activated mutator'.

Medical Libraries in the British Isles

MR. W. R. LE FANU'S paper, "A List of Medical Libraries and Information Bureaux in the British Isles", in the *Journal of Documentation* of December 1946 is now available separately from the Association of Special Libraries and Information Bureaux (3*s*.). The list is based on a questionnaire issued by the Association in the autumn of 1944 to libraries known to possess medical collections and to hospitals, medical societies and medical institutions throughout the British Isles. Special libraries of pharmacy and veterinary medicine are included, but not those of anthropology or the biological sciences, except anatomy and physiology. Libraries and information

bureaux are listed separately, the latter being institutions without libraries which have an active policy of gathering and disseminating information. The annotated lists are arranged alphabetically first for London, and then, separately, those outside London. A list of medical libraries holding periodicals registered in the World List and Union Catalogue is appended with an index of special collections and subjects.

Aerial Photographs for Scientific Purposes

FROM time to time aerial photographs are required for scientific purposes. Facilities for such photographs, required for non-commercial scientific purposes, may be provided by the Royal Air Force and Royal Navy, but such facilities are limited, and priority must, therefore, be allocated to the various requirements. The Advisory Committee on Airborne Research Facilities, a joint committee of the Royal Society and the Services, is to advise the Services on this matter. Requirements for photographs to be taken during 1948 should be forwarded to the Committee, at the Royal Society, Burlington House, London, W.1, before October 31, 1947; it will assist (*a*) if the envelope is marked 'Aerial Photographs'; (*b*) if grid references on the ordnance survey G.S.G.S. 1 in. series are quoted, alternatively exact latitude and longitude; and (*c*) if the scale required is stated. (It should be noted that cover is easier to provide in scales of 1/10,000 or 1/25,000.)

University of Birmingham: Appointments

THE chair of production engineering established two years ago by a munificent gift from Messrs. Joseph Lucas, Ltd., has been filled by the appointment of Dr. T. U. Matthew, director of research of the Bedaux Company for Africa, Ltd. Dr. Matthew's exceptional ability, capacity for research, experience of the technical as well as the production and administrative sides of engineering, his wide interests and scholarly mind will enable him to fill the post with distinction and success. He had a brilliant career at King's College, London, and in post-graduate research at Cambridge. The chair of production engineering was established "to foster through research the full development of every aspect of Production Engineering and the education through special post-graduate courses of a supply of men who possess not only a sound grasp of the fundamentals of engineering but also a specialized knowledge of production methods and processes and the varied aspects of organisation and control".

The chair of zoology has been filled by the appointment of Mr. P. B. Medawar, lecturer in zoology in the University of Oxford and a fellow of Magdalen College.

Prof. V. G. Childe, professor of prehistoric European archæology in the University of London, has been appointed Mason Lecturer for 1947–48.

Commonwealth Fund Fellowships Awards

THE Committee of Award of the Commonwealth Fund Fellowships has made the following appointments, among others, to fellowships tenable by British graduates in American universities for one year beginning September 1947: J. P. Bentley, Charing Cross Hospital Medical School and King's College, University of London, to Emory University, Atlanta, Georgia, in surgery; M. R. Bonham Carter, Balliol College, Oxford, to the University of Chicago, in political science; R. P. Brittain, University of Glasgow, to New York University College of Medicine, in forensic medicine; A. J. Y. Brown, University of Aberdeen, to the University of California, in economics; W. J. G. Cameron, College of Technology, Queen's University, Belfast, and Queen Mary College, University of London, to the University of Illinois, in engineering; F. J. Dyson, Trinity College, Cambridge, and Imperial College of Science and Technology, University of London, to Cornell University, in mathematics; F. H. Holmes, University of London, to Princeton University, in chemistry; Dr. James Innes, University of Edinburgh, to Washington University, St. Louis, in medicine; D. S. Jones, Corpus Christi College, Oxford, to the Massachusetts Institute of Technology, in mathematics; Dr. I. C. Jones, University of Liverpool, to Harvard University, in zoology; James Kenny, University of Glasgow, to Princeton University, in economics; Dr. G. A. Maw, University College, University of London, to Cornell University Medical School, in biochemistry; Bowman Scott, Imperial College of Science and Technology, University of London, to Harvard University School of Business Administration, in engineering; Alexander Slessor, University of Glasgow, to Harvard University Medical School, in medicine; Dr. Harry Stalker, University of Edinburgh, to Cornell University Medical School, in medicine.

The following have been appointed to fellowships tenable by candidates holding appointments in the Home Civil Service: T. F. Bird, Balliol College, Oxford, and London School of Economics, University of London, of the Ministry of Civil Aviation; C. E. Calveley, King's College, University of London, of the Post Office; J. A. R. Pimlott, Worcester College, Oxford, of the Lord President's Office; J. B. Williams, McGill University, and Trinity College, Cambridge, of the Colonial Office (fellowship awarded in 1939).

Announcements

AT a Congregation at the University of Cambridge on June 12, eleven honorary degrees were conferred, including that of Sc.D. on: Prof. Linus C. Pauling, professor of chemistry in the Californian Institute of Technology; Sir Edward Mellanby, secretary of the Medical Research Council; Prof. C. T. R. Wilson, emeritus professor of natural philosophy in the University of Cambridge.

PROF. V. G. CHILDE, professor of prehistoric European archæology in the University of London, has been elected a member of the Royal Netherlands Academy of Sciences of Amsterdam (Section of Letters and Historical Sciences).

THE Commissioners for the Exhibition of 1851 announce the award of senior studentships for 1947 to the following: On the recommendation of the University of Cambridge: J. S. Courtney-Pratt, for research in physics at the University of Cambridge. On the recommendation of the University of Oxford: D. H. Whiffen, for research in physical chemistry at the University of Oxford; E. M. Vaughan-Williams, for research in pharmacology at the University of Oxford. On the recommendation of the Imperial College of Science and Technology, London: Dr. K. D. Froome, for research in physics at the Imperial College of Science and Technology, London.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Aromatization of *cyclo*Hexane Carboxylate in Liver Slices

A FEW examples of the occurrence of aromatization of alicyclic compounds in the animal body are known, and similar reactions have been suggested in the formation of sex hormones and possibly carcinogens from sterols and bile acids[1]. Hitherto, however, the reaction has not been demonstrated in isolated tissues. The ready conversion of *cyclo*hexane carboxylic acid to benzoic acid by the dog, man and rabbit[2] suggested investigation of this transformation as a preliminary to the fuller study of aromatization in tissues. Rabbits of about 2·8 kgm. weight were first fed or injected subcutaneously with doses of 1·6–2·6 gm. sodium *cyclo*hexane carboxylate, of which about 0·9 gm. was isolated in the form of hippuric acid from the urine passed in the next 24 hours, thus confirming the work of Bernhard[2], and showing an adequate rate of aromatization. A method was evolved[3] for the micro-estimation of benzoic or hippuric acid in presence of *cyclo*hexane carboxylic acid, depending on cold nitration to the *m*-nitro derivative, reduction of the latter to the amino-compound, and estimation by diazotization and coupling with N-(1-naphthyl)-ethylene diamine.

FORMATION OF BENZOIC ACID FROM *cyclo*HEXANE CARBOXYLATE BY RABBIT TISSUES

	Q^* benzoic acid
Liver slices, O_2, phosphate	0·19
" " " + HCN	0·04
" " N_2 "	0·01
" " $O_2 + CO_2$, bicarb.	0·26
" " " + HCN	0·06
Liver homogenate, O_2, phosphate	0·04
Kidney slices " "	0·09
Skeletal muscle " "	0·004
Blood	0·025
Testis	0·00
Spleen	0·00

Liver slices in phosp., O_2, *cyclo*hexane carboxylate molarity as follows:

	0·10	0·05	0·025	0·01	0·004	0·001 *M*
$Q_{benzoic}$	0·03	0·08	0·11	0·16	0·19	0·22

* To convert $Q_{benzoic}$ to μgm. benzoic acid/mgm. dry wt. tissue per hour, multiply by 122/22·4 = 5·44.

The extent of formation of benzoic (or hippuric) acid from added *cyclo*hexane carboxylate by rabbit tissues is shown in the accompanying table. This aerobic oxidation occurs mainly in liver and kidney, is inhibited by anaerobic conditions or in presence of cyanide, and by homogenization of the tissue. Derivatives of *cyclo*hexane carboxylate (hexahydrohippuric acid and hexahydrobenzamide) are also aromatized. The reaction appears to be complex, involving intact cell structure and iron-containing respiratory enzymes. Attempts to prepare a dehydrogenase have as yet been unsuccessful.

It is remarkable that the formation of benzoic acid is strongly and increasingly inhibited by *cyclo*hexane carboxylate, even by concentrations (above 0·001 *M*) which scarcely affect the total respiration (see table). This fact makes isolation of the product more difficult, and for this purpose two 45-gm. portions of a sliced rabbit liver (total weight 95 gm.) were suspended in 450 ml. bicarbonate – Ringer solution (*a*) without, (*b*) with *cyclo*hexane carboxylate, 0·0012 *M*. After shaking for 3 hours at 38° in oxygen plus 5 per cent carbon dioxide, the solutions contained, by analysis, (*a*) 0·30 mgm., (*b*) 33·6 mgm. benzoic acid, that is, 55 per cent conversion of the added *cyclo*hexane carboxylate. The 60 per cent ethanol extracts were concentrated *in vacuo*, treated with tungstic acid, and extracted with ether for 20 hours. Recrystallization from water of the ether concentrate of (*b*) yielded 26 mgm. hippuric acid, identified by m.p., mixed m.p., and by m.p. and analysis of the *p*-nitrobenzyl ester. The source and function of the glycine used for conjugation are being examined.

The occurrence of aromatization in liver slices at a rate comparable with that in the intact animal is thus demonstrated, and other examples of this biologically important reaction are now being sought.

F. DICKENS

Courtauld Institute of Biochemistry,
Middlesex Hospital Medical School,
London, W.1.
April 24.

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Spectroscopic Estimation of Penicillin *G*

THE presence of a phenyl group enables penicillin *G* to be estimated in mixtures containing other penicillins of non-aromatic type. The spectra were photographed on Ilford Autofilter plates with a Hilger medium quartz spectrograph (*E* 498) using the continuous radiation from a hydrogen discharge lamp; an exposure of 30 sec. was needed with a slit width of approximately 0·05 mm. Under these conditions, phenyl absorption bands at 2685, 2645, 2585 and 2525 A. are observed with a solution of sodium penicillin *G* in a mixture (1 : 30) of water and ethanol having a concentration of 15 mgm./ml. at a path-length of 1·5 mm.

To compare the penicillin *G* contents of different samples of penicillin, the method of matching developed by Dr. W. C. Price[1] is used. The spectrum of the sample under investigation is photographed several times on a plate, using a series of path-lengths, which are varied by means of a Hilger micrometer cell or a wedge cell. Alongside each exposure is recorded the spectrum of a standard penicillin solution, using the same path-length each time. The path-length at which the spectrum of the unknown solution matches that of the standard is estimated by eye, interpolating between spectra when necessary. The relative concentrations of the two solutions are given by the inverse ratio of the path-lengths.

As an alternative to penicillin *G*, an alcoholic solution of phenyl acetamide (9 mgm./ml. at 1 mm. path-length) can be used as a sub-standard. Its spectrum is not identical with that of penicillin *G*, since the unspecific absorption of the penicillin molecule overlies some of the phenyl absorption bands, but matching is possible at 2685 A. and 2645 A. In penicillin *G*, these bands are displaced slightly (less than 3 A.) to shorter wave-lengths, and the displacement increases as more water is added to the solvent until, in water alone, it is about 12 A. and the bands are then very diffuse. The molar extinction coefficients of a reputedly pure sample of penicillin *G* and of phenyl acetamide were found to be the same at the matching wave-lengths. Recently, however, samples of sodium penicillin *G* have been prepared here that have an apparent purity of 104 per cent

when compared in this way, and, clearly, the real penicillin *G* content of a sample cannot be determined until the spectrum of phenyl acetamide has been compared with that of pure sodium penicillin *G*. In the meantime, figures can be obtained which are in error only to the extent that the standard penicillin is impure.

If all the absorption at 2685 and 2645 A. were due only to penicillin *G*, a spectrophotometer could be used instead of matching. Unfortunately, in all but very pure samples of penicillin, the spectrum shows, in addition to the phenyl bands, a continuous absorption due to impurities, so that estimates from optical densities would be high. In the analysis of hydrocarbons, however, it has been found that, provided the additional unspecific absorption is not too strong, the pattern of a spectrum is not affected and can be used for matching. Similarly, we have found that the spectra of pale yellow samples of penicillin which give definite greying of the photographs can be matched against the spectrum of phenyl acetamide. The estimated error of the method is ± 2 per cent when the unspecific absorption is small; when it is large, matching is more difficult and results tend to be high.

With very yellow samples of penicillin, the method fails. In such instances, the samples can be oxidized with potassium permanganate solution at 100° C., the resulting suspension cleared with sulphur dioxide and an aliquot portion diluted with four times its volume of ethanol, filtered and matched as described above against a standard made by dissolving benzoic acid in ethanol and diluting with a quarter the volume of water. It was established by treating the purest available specimen that the oxidation of penicillin *G* to benzoic acid is quantitative. The presence of ethanol is essential, as the bands at 2810 and 2730 A., used for matching, do not appear in aqueous solution.

It should be emphasized that both these methods estimate all phenyl groups, including any that are present in deactivated products or impurities. With fairly pure samples, this does not appear to introduce serious errors; but with cruder preparations, results are correspondingly less reliable.

We are indebted to Dr. R. H. Hall for carrying out the oxidations, and to the directors of the Distillers Co., Ltd., for permission to publish this work.

A. R. Philpotts
W. Thain
G. H. Twigg

Research and Development Department,
The Distillers Co., Ltd.,
Great Burgh,
Epsom, Surrey.
March 21.

[1] W. C. Price, private communication.

Antibiotic Agents in the Substrates from Cultures of the Genus *Marasmius*

During current investigations into the production of antibiotic substances by Hymenomycetes, it was found that certain species of the genus *Marasmius* had a marked inhibiting effect upon growth of *Staphylococcus*.

In testing for antibiotic properties, the fungi were grown as surface felts on stationary shallow layers in Erlenmeyer flasks of 100 ml. capacity. The culture vessels used were made of special resistance glass; it had been found that the minute amounts of inorganic elements entering the nutrient solution from chemically resistant glassware of less satisfactory quality on sterilization in the autoclave were able to cause serious irregularities in the formation of antibacterial agents[1]. The synthetic nutrient media employed in the qualitative tests and in preliminary attempts to increase the yields of antibiotic substance contained, besides the usual mineral salts, glucose as the source of carbon and energy, and ammonium nitrate, ammonium chloride, or ammonium tartrate as the source of nitrogen. The media were supplemented with thiamin (1 γ per 25 ml.), and, in some cases, with biotin (0·05 γ per 25 ml.); these growth factors, added singly or together, being indispensable for normal growth of the fungus species tested[2]. The vitamin preparations used were thiamin hydrochloride Merck (Darmstadt) and biotin Merck (Rahway, N.J.). In some culture series the media contained small quantities of zinc, calcium and manganese added from dilute stock solutions of sulphates or chlorides, these minor elements being essential for, or promoting highly, the growth of species of *Marasmius*[2]. In other culture series the basal media were supplemented with 'Vitrum' malt extract or water extracts of aspen litter, the latter material containing organic and inorganic substances effective as growth-stimulating agents upon soil fungi of different biological groups[2–5]. The culture media were buffered to the respective optimum *p*H values by the addition of hydrochloric acid and solutions containing mixtures of mono- and dihydrogen phosphates. The nutrient solutions were sterilized by heating in the autoclave for 15 min. at a temperature of 120° C. or by passing through a Seitz filter. Each culture flask contained 25 ml. of the respective substrates.

The contents of the flasks were inoculated with square bits cut out from colonies of the fungi grown in Petri dishes on ordinary malt agar or on agar media made up with synthetic nutrient solution and malt extract. The area of each piece of inoculum was about 4 sq. mm. The cultures were incubated in the dark at a temperature of 25° C., great care being taken to keep the small pieces of inoculum floating on the surface of the substrate.

In order to gain information about possible relationships between growth of mycelium and formation of antibiotic substance, cultures of the different series were harvested at intervals of one or a few days, the fungal mats being weighed after thorough washing in distilled water and drying for 24 hr. at 100–102° C., and the substrates being tested for antibacterial activity against *Staphylococcus aureus* No. 266 by means of the cylinder plate method[1,6]. In addition, the hydrogen ion concentration of the substrates was determined electrometrically at all points of observation.

Both *Marasmius graminum* (Lib.) Berk. and Br. ap. Berk. and *M. ramealis* (Bull. ex Fr.) Fr. were found to be highly active producers of antibacterial agents on all the media tested. However, the formation of substances effective against *Staphylococcus* starts at different times on the different media. The duration and maximum level of antibiotic activity also vary considerably with composition of the medium. *M. foetidus* (Sow. ex Fr.) Fr. and *M. scorodonius* (Fr.) Fr. proved highly active against *Staphylococcus*. *M. alliaceus* (Jacq. ex Fr.) Fr., *M. androsaceus* (L. ex Fr.) Fr. and *M. rotula* (Scop. ex Fr.) Fr. were practically inactive under the conditions of the assay method used.

A more detailed account of the results of this investigation will be published in due course in Swedish journals of botany.

ELIAS MELIN
TORSTEN WIKÉN
KARIN ÖBLOM

Institute of Physiological Botany,
University of Uppsala.
March 26.

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Use of Potassium in the Assay of Curare

Now that tubocurarine, one of the curare alkaloids, is gaining importance in medicine, it is important that this compound and other curare-like substances should be biologically standardized. A suitable method has been described by Chou[1], utilizing the rat's phrenic nerve-diaphragm preparation of Bulbring[2]; but we have been unable to obtain consistent results with this technique. By using temperatures lower than usual for mammalian tissue work (namely, room temperature, about 20° C.), we have obtained satisfactory results. The preparation lasts for a much longer period of time, shows little sign of fatigue after eight hours, and contractions are more regular. Larger doses of tubocurarine are needed than those used at 37° C., and a reduction in contraction of approximately 50 per cent is obtained with 0·15 mgm.

The difficulty with this technique is that the preparation requires a long time for complete recovery (more than 30 min.); but this has been overcome by the addition of small amounts of potassium ions to the bath during recovery phase, after the curare action has been shown for 3–5 min., according to the preparation. The anti-curare action of potassium is well known. When recovery is complete, the potassium is washed out and the next dose of curare-like substance is added (a total of 6–10 min. after the last dose). Potassium chloride itself exerts a stimulating action in this preparation in small doses (20–30 mgm.), whereas in larger doses (80–100 mgm.) the depressant effect predominates. These quantities refer to an isolated organ bath of 75 ml. capacity.

P. Gª. DE JALON
G. B. WEST

College of the Pharmaceutical Society,
London, W.C.1.
April 12.

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Leukotaxine and Histamine

INFLAMMATORY exudates contain a polypeptide, leukotaxine, which has, among other properties, that of inducing increased capillary permeability on intracutaneous injection[1,2,3]. Other observations suggest that histamine may play a fundamental part in wheal formation of allergic and non-allergic origin[4–9]. It has therefore been suggested that the active factor in inflammatory exudates is really histamine and not leukotaxine, or that leukotaxine, if it exists, induces an increased permeability of the capillaries only through the mediation of histamine[8].

That leukotaxine is not histamine is suggested by the observations[1,3] that: (1) leukotaxine does not cause contraction of the isolated guinea pig ileum; (2) histamine is not chemotactic for leucocytes, but leukotaxine is; (3) intravenous injection of leukotaxine does not lower the blood pressure of the cat.

Moreover, crude preparations of leukotaxine, prepared by the method of Cullumbine and Rydon[2], when extracted for histamine (Barsoum and Gaddum's method[10]) and assayed on the isolated guinea pig ileum, yield insignificant quantities of histamine; for example, 6 mgm. (550 'units') of crude leukotaxine contained less than 2 μgm. of histamine.

We have used the anti-histamine substance 'Neoantergan', or 2786 R.P., which prevents or diminishes the action of histamine in increasing capillary permeability[11,12] in further studies on the mode of action of leukotaxine and the production of œdema following cutaneous burning.

We have observed that rabbits burned under nembutal anæsthesia, by exposing their depilated abdomens for 90 sec. to a glass vessel containing water at 70° C., develop extensive subcutaneous œdema of the abdominal wall within two to four hours of burning. The subcutaneous injection of 'Neoantergan' in a 10 mgm./kgm. dose (half the subcutaneous dose of this drug required to produce toxic symptoms in the rabbit) 30 min. before, or immediately after, or one hour or two hours after burning did not apparently affect the rate of development of the œdema or the degree of œdema produced by the burning.

Each burned area of skin yielded 30,000–60,000 'units' of leukotaxine. The intracutaneous injection of 60,000 'units' of leukotaxine into the abdominal wall of normal rabbits or rabbits medicated with 'Neoantergan' (10 mgm./kgm.) produced an œdema comparable to that induced by the burning.

If 1·25 c.c./kgm. of a 5 per cent solution of Pontamine Blue in 0·6 per cent saline is injected intravenously into a rabbit, and then a solution (0·2 c.c.) of leukotaxine or of histamine is injected intracutaneously into the depilated abdominal wall of the rabbit, blue areas rapidly develop at the sites of the cutaneous injections. 'Neoantergan' administered: (1) subcutaneously in a 10 mgm./kgm. dose and 30 min. before the test agents (0·2 c.c. of solutions containing 0·1 mgm. crude leukotaxine/c.c. or 0·1 mgm. histamine/c.c. respectively); or (2) intracutaneously (0·2 c.c. of a solution containing 40 mgm./c.c.) at the sites of injection of the test agents and immediately after the test agents; or (3) intracutaneously in a solution containing 40 mgm. 'Neoantergan'/c.c. and 0·1 mgm. crude leukotaxine/c.c. or 0·1 mgm. histamine/c.c., did not prevent the development or diminish the intensity of the blue staining at the sites of injection of the leukotaxine solution, but did completely prevent the blue staining at the sites of the histamine injection.

These observations suggest that the local liberation of histamine is not necessary for the production of subcutaneous œdema after cutaneous burning in the rabbit, and that leukotaxine does not induce an increased capillary permeability through the mediation of histamine. But the evidence is not conclusive, since the doses of 'Neoantergan' used, although large, may have been inadequate to deal with the amount of histamine that may have been liberated locally by the leukotaxine preparations. Higher concentrations of 'Neoantergan' cannot be used locally, since this drug itself, on intracutaneous injection in high con-

centration, produces a positive blue reaction and so may mask the leukotaxine reaction. This local irritant action of 'Neoantergan' suggests that histamine cannot take an intermediary role in the production of increased capillary permeability during the inflammatory reaction.

H. CULLUMBINE

Department of Pharmacology,
University of Manchester.
April 5.

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Serum Bilirubin and the Van Den Bergh Reaction

THE problem of the nature of direct and indirect bilirubin remains obscure, in spite of many attempts to explain the phenomenon of the two types of reaction.

Some authors[1] still believe that direct bilirubin is free, and that indirect bilirubin is combined with serum protein, and alcohol converts one to the other, as does the liver, by an uncoupling action. However, this view seems no longer tenable since much evidence is available to show that both forms of bilirubin are combined with serum albumin[2-4]. The dual reaction is ascribed to the different strength of attachment of the pigment to the protein[5,6].

In our experiments no evidence was obtained supporting this view. The burden of the investigation is as follows:

(1) Addition of the most active promoting substances was without effect upon the attachment to protein, as deduced by dialysis and ultrafiltration experiments. Caffeine was exceptional in causing fission, although its effect in the van den Bergh reaction is more delayed.

(2) The final product, azobilirubin, was found to be combined with serum protein in every case. It is clear, therefore, that the behaviour of bilirubin is not to be explained by its liberation from protein attachment.

(3) Enzyme digestion of serum containing bilirubin or artificial bilirubin-protein compounds (prepared from serum albumin, serum globulin, globin or casein) by means of papain or pancreatin under optimum conditions caused no change of reaction. The reaction was indirect in each case, before and also following enzyme digestion, suggesting that neither the type of protein (cf. ref. 6) nor its size is a critical factor in the rate of production of azobilirubin.

(4) In addition to those substances known to change indirect to direct reacting bilirubin (ethanol, acetic acid, acetone, caffeine), we have found that pyridine exhibits this action in low concentration (5 per cent in serum) without precipitating the serum proteins or diluting the final colour. The introduction of pyridine in the van den Bergh test for bilirubin would bring many advantages.

(5) In a comparative study of the promoting effect of several alcohols, methanol, ethanol, propanol and isopropanol were equally active, higher alcohols less active, and glycerol and ethylene glycol gave negative results.

(6) No specific factor able to facilitate the van den Bergh reaction with bilirubin could be demonstrated or separated from direct sera, nor does there appear to be an inhibitor in indirect serum. Examination was made both of native serum and also following enzyme digestion to detach adsorbed substances from the protein.

(7) It is apparent that differences in the type of reaction must be ascribed to the pigment itself. The possibility arises that indirect bilirubin may be an intermediate precursor of bilirubin in hæmoglobin breakdown, still attached to globin, the precipitation reactions of which simulate those of serum albumin. This supposition has received experimental support, because direct-reacting serum when mildly oxidized with 0·3 per cent hydrogen peroxide under controlled conditions exhibits the characteristic behaviour of indirect serum bilirubin with the van den Bergh reagent and alcohol or pyridine.

C. GARDIKAS
(British Council Scholar)
J. E. KENCH
(Sir Halley Stewart Fellow)
J. F. WILKINSON

Department of Clinical Investigation
and Research,
Manchester Royal Infirmary.
March 19.

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Neutral Auxins

IN a previous paper[1], I have presented evidence that 3-indole acetaldehyde is a growth hormone in higher plants. Since this substance has not been prepared in the pure state, only indirect evidence that the auxin found is actually 3-indole acetaldehyde could be provided. Dr. K. A. Jensen, of the Chemical Laboratory, University of Copenhagen, has made a crude preparation of 3-indole acetaldehyde which I have tested. It proved to act in the same way as the neutral fraction of ether extracts of etiolated plants and as the crude preparations obtained by treatment of tryptophane with isatin or ninhydrin. The attempts to synthesize 3-indole acetaldehyde are being continued and will be reported elsewhere. In addition, an investigation on a series of other non-acid homologues of acid auxins has been started. Some of the results of this work are given below.

The accompanying table gives the relative activity of the compounds tested, based on the concentrations required for 5° curvature in the *Avena* test as carried out in this Laboratory, using soil-grown test plants. The values for 3-indole acetaldehyde are based on determinations obtained after the aldehyde had been converted to 3-indole acetic acid by treatment with soil[1]. The values have been corrected for a destruction of 50 per cent which is also caused by the soil in the procedure used (destruction was determined in experiments with the pure acid). These

Substance tested	Concentration required for 5°* curvature in the *Avena* test Mgm./l.	Relative activity	Maximum angle	
			Mgm./l.	Degrees*
3-Indole acetic acid	0·026	100	0·15	58
3-Indole acetaldehyde	0·125?	20 ?	0·20	20–50
3-Indole ethyl alcohol	250	0·01	450	8·5
α-Naphthalene acetic acid	0·09	29	2·7	30
α-Naphthalene acetaldehyde	48	0·05	120	14
Phenyl acetic acid	2500	0·001	10^4	8
Phenyl acetaldehyde	—	7×10^{-4}	3×10^4	6

* 5° curvature corresponds to a *d*-value of 0·10 (*d* is the difference in length between the inner and outer side of the curved coleoptile, measured in mm.).

values are, of course, uncertain ; the relative activity may be between 10 and 40. 3-Indole ethyl alcohol (tryptophol) and α-naphthalene acetaldehyde were prepared by Dr. K. A. Jensen. These substances, as well as phenyl acetaldehyde, were freed from possible traces of acid substances by shaking ethereal solutions with alkaline water immediately before the test ; phenyl acetaldehyde was redistilled before shaking. As 5° curvature is near the maximum angle produced by the latter substance, its relative activity was calculated on the basis of 3° curvature. In the table are also shown the maximum angles for the compounds tested and the concentration needed for maximum curvature.

Other workers (using water-cultured test plants) found the relative activities of alpha-naphthalene acetic acid and phenylacetic acid to be 2·5 and 0·02, respectively (compare Veldstra's list[2]). These values do not agree with those given here, obtained on soil-grown plants. This discrepancy may be due to the different methods of cultivating the test plants.

3-Indole acetaldehyde could be oxidized to 3-indole-acetic acid by treatment either with raw milk, with a purified Schardinger enzyme preparation (aldehydrase) or with soil. By soil treatment the activity of the aldehyde preparations was increased about 2·5 times. Soil treatment of indole ethyl alcohol and of alpha-naphthalene acetaldehyde preparations increased their activities by 100 and 20 times, respectively, indicating that these compounds are also oxidized by the soil, with the formation of the much more active acids.

Poul Larsen

Laboratory of Plant Physiology,
University of Copenhagen.
March 17.

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Molecular Weight of Melanin

A method of obtaining protein macro-molecules in crystalline form by the use of heparin has been described by Cohen[1]. As melanin is generally believed to have a high molecular weight, an attempt has been made to crystallize it by Cohen's method, using ethylene chlorhydrin as solvent. Heparin is not soluble to any appreciable extent in pure ethylene chlorhydrin ; but both it and melanin are soluble in a mixture of equal parts of water and ethylene chlorhydrin. 'Dopa' and *Sepia* melanin have been used, with concentrations of heparin of 1, 2, 5, and 10 per cent, with and without addition of electrolyte (sodium chloride), at temperatures varying from −20° to 20° C. The attempt has failed completely, no precipitate being observed under any conditions even after standing for seven days.

It was observed by Cohen that although a number of highly complex proteins were precipitated by this method, those of comparatively low molecular weight, for example, gelatin, edestin and pepsin, did not respond, even with concentrations of heparin up to 10 per cent. This suggests, though by no means proves, that the molecule of melanin may not be so large as has been supposed. Further work at present in progress tends to support this view.

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A. J. Lea

Medical Services,
Ministry of Pensions,
Norcross, Blackpool.
March 16.

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Free Radicals from Benzyl Hyponitrite

We have recently prepared benzyl hyponitrite by the method of Partington and Shah[1], and have found that it readily catalyses the polymerization of methyl methacrylate at room temperatures. At 30° C. the rate of polymerization of methyl methacrylate initiated with benzyl hyponitrite is approximately thirty times as fast as the rate observed with an equal amount of benzoyl peroxide.

The polymerization of this monomer is known to be initiated by free radicals, and the benzyl hyponitrite must therefore produce free radicals by decomposition. By analogy with other compounds containing the —N=N— group which are sources of free radicals, it is probable that benzyl hyponitrite decomposes into two benzoxy radicals $C_6H_5CH_2O$— with the elimination of nitrogen. The formation of benzaldehyde and benzyl alcohol in presence of water reported by Partington and Shah could then be due to disproportionation of these benzoxy radicals.

Ivan Harris
Ian Marshall
Kenneth Barry Jarrett

Research Department,
Imperial Chemical Industries Ltd.,
Plastics Division, Tewin Road,
Welwyn Garden City.

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Addition of Dinitro Compounds to D.D.T. to Prevent Outbreak of Spider Mites

It is frequently observed that the use of sprays containing D.D.T. on fruit trees leads to a severe outbreak of Tetranychid mites or red spiders. In the United States, for example, *Tetranychus pacificus* McG., *Paratetranychus pilosus* C. & F. and *P. citri* McG. have all been found to increase very considerably after D.D.T.-spraying has killed the predaceous insects which normally keep them under control. Research workers who have obtained excellent control of codling moth (*Cydia pomonella* L.) or other pests with D.D.T. have felt unable to recommend its general use owing to the risk of producing a severe mite infestation. It may therefore be of interest to record a method by which this difficulty was over-

come by the addition of dinitro-*ortho-cyclo*hexylphenol to the spray. The successful use of this material in the United States has been recorded, but does not appear to be widely known even there; and it has never previously been tested on *Bryobia* mite, the prevailing 'red spider' of South African and Australian fruit crops.

Spraying trials against codling moth were carried out in South Africa during the 1946–47 season at Elgin, Cape Province, in collaboration with the Western Province Fruit Research Station, Stellenbosch. Two D.D.T. preparations were used, a xylene emulsion and a dispersible powder, both diluted to give 0·1 per cent actual D.D.T. The remainder of the orchard received the standard treatment with a proprietary nicotine–bentonite preparation. By the end of December, after five sprays, a heavy outbreak of *Bryobia praetiosa* Koch was evident on the D.D.T.-sprayed trees, but there were very few on those which received nicotine. After this time, owing to shortage of supplies, it was unfortunately necessary to use a proprietary fixed nicotine containing 0·05 per cent D.D.T., and the red spiders then began to increase also on these plots. On January 8 and 19 and February 9, 1947, half of each plot was sprayed with D.D.T. containing dinitro-*ortho-cyclo*hexylphenol in the form of its di*cyclo*hexylamine salt at 0·00625 per cent. A sample of the red spider population taken on February 17 gave the result shown in the following table, in which the figures for the active and 'resting' stages are combined.

Summer spray schedule	Total spiders per 16 leaves	
	Without dinitro compound	With dinitro compound in 3 sprays
D.D.T. (0·1%) emulsion, 9 sprays	644	32
D.D.T. (0·1%) dispersible powder, 9 sprays	768	26
Fixed nicotine (0·05%) in first 4 sprays and fixed nicotine (0·025%) + 0·05% D.D.T. in last 5 sprays	246	175

The protection against *Bryobia* mite afforded by the addition of dinitro-*ortho-cyclo*hexylphenol, used even after an outbreak had started, is evident from the above figures. The dinitro compound is not so effective when used with fixed nicotine, presumably owing to formation of a nicotine salt of dinitro-*ortho-cyclo*hexylphenol, which is less toxic than the di*cyclo*hexylamine salt, or to adsorption on the bentonite. This point is being further investigated.

R. M. Greenslade
E. G. Goscombe

Pest Control, Ltd.,
Cambridge.
March 17.

Autoxidation of Olefins: Formation of Unsaturated Alcohols from Olefins by the Action of Organic Peracids

It was reported in a previous communication[1] that peracetic acid reacts with α- and β-di*iso*butylenes to give an unsaturated alcohol and high-boiling material of the molecular formula $C_{16}H_{32}O_2$ in addition to the expected glycol. Thus β-di*iso*butylene (I) yields the unsaturated alcohol (II) with alteration in the position of the double bond; α-di*iso*butylene (III) gives rise to the two unsaturated alcohols (IV) and (V).

$Me_2C.CH{:}CMe_2$ (I) $\quad Me_2C.CH(OH).CMe{:}CH_2$ (II)

$Me_2C.CH.CMe{:}CH_2$ (III) $\quad \begin{cases} Me_2C{:}CH{:}CMe.CH_2(OH) & (IV) \\ Me_2C{:}CH_2.C(CH_2OH){:}CH_2 & (V) \end{cases}$

It is now found that the formation of these unsaturated alcohols does not depend on substitution of the olefin, but on the isomerization of the epoxide which is an intermediate in the reaction.

Thus 2 : 4 : 4-trimethylpentan-2 : 3-epoxide (VI) on treatment with acetic acid containing a trace of sulphuric acid gives 2 : 4 : 4-trimethylpenten-1-ol-3 (VII), the mono-acetate of 2 : 4 : 4-trimethylpentan-2 : 3-diol, and a high boiling liquid which is provisionally formulated as a tetramethyl di-*tert.*-butyl 1 : 4-dioxane. These are the main products of the reaction; but there is also formed an aldehyde which is presumably 2 : 2 : 3 : 3-tetramethylbutanal. The yield of unsaturated alcohol in this reaction is approximately equal to that of the glycol; that of the dioxane is rather less, while the aldehyde is only a minor product.

$$Me_2C.CH.CMe_2 \;(VI) \;\rightarrow\; Me_2C.CH(OH).CMe{:}CH_2 \;(VII)$$

A change in the position of the double bond during the peroxidation of an olefin by molecular oxygen is said to occur[2–4], and it has been suggested[5,6] that the preliminary phase is the formation of a moloxide by saturation of the double bond by a molecule of oxygen. The hydroperoxide would then result by opening of the moloxide ring and change in position of the double bond.

The work described above now provides experimental support for this hypothesis by the demonstration that a similar system, namely, the epoxide ring, can behave in the manner postulated. Further, it suggests, if the analogy between the two types of oxygenated ring systems may be maintained, that the opening of the ring system may be accompanied by the formation of bimolecular oxygenated compounds and also carbonyl compounds. Such compounds are always formed during the peroxidation of olefins[7,8], and it might well be that they are formed at the same time as the hydroperoxide.

Further evidence that the double bond of the olefin is the initial point of attack during peroxidation is the presence of an epoxide among the products of air oxidation[8,9]. Although it is possible to explain these observations by assuming that the epoxide arises by a reaction of the hydroperoxide with the olefin, it may equally well arise from the moloxide by a side reaction.

W. J. Hickinbottom

Department of Chemical Engineering,
University,
Birmingham 15.
March 22.

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[2] Farmer and Sutton, *J. Chem. Soc.*, 119 (1943).
[3] Bergström, *Nature*, **156**, 717 (1945).
[4] Gunstone and Hilditch, *J. Chem. Soc.*, 1024 (1946).
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The Meson Spectrum Near Sea-Level

L. Jánossy and J. C. Wilson determined, some time ago[1], from a comparison of theoretical and experimental spectra at sea-level the exponent γ in the production spectrum of mesons $dN = \text{const.}\ p^{-\gamma}dp$; they find a value $\gamma = 3{\cdot}3$. As this value differs appreciably from the ordinarily accepted one, we have thought it worth while to check the above result by a more accurate method, taking account of the variable energy-loss of mesons through the atmosphere.

The basis of our computation is a formula for the vertical meson spectrum at sea-level derived by M. E. Rose[2] with the hypothesis of an initial $\varepsilon^{-\gamma}$ spectrum. This formula is

$$f(\varepsilon,t_s)d\varepsilon = C_0 \frac{B(\varepsilon')}{B(\varepsilon)} \varepsilon'^{-\gamma} \exp(-\alpha D)d\varepsilon,$$

where ε' is the energy at the production level of a meson having energy ε at sea-level; $B(\varepsilon)$ is the energy loss $-\frac{d\varepsilon}{dt}$ (t in gm./cm.^{2}); $\alpha = \frac{t_s}{\rho_s c\tau_0}$ (with t_s height of the atmosphere in gm./cm.^{2}, ρ_s air density at sea-level, $c = 3 \times 10^{10}$ cm./sec., and τ_0 mean life of the meson at rest); D is the integral $\int_{R_0}^{R_s} \frac{dR}{tp(R)}$, with R_0, R_s residual ranges (in gm./cm.^{2}) of mesons of energies ε' and ε (p momentum of the meson).

Rose's expression is quite different from that given by Euler and Heisenberg[3], owing to a different treatment of the absorption of mesons. However, it is easily verified that it satisfies the following differential equation:

$$\frac{\partial f}{\partial t} = B(\varepsilon)\frac{\partial f}{\partial \varepsilon} + f\frac{dB(\varepsilon)}{d\varepsilon} - f\frac{\alpha}{pt},$$

where $f(\varepsilon,t)$ is the differential energy spectrum at level t. This equation is the generalization of that of Euler and Heisenberg to the case of variable energy loss (and energy- instead of momentum-distribution).

Assuming an initial spectrum $p^{-\gamma}$, instead of $\varepsilon^{-\gamma}$, Rose's formula becomes

$$dN = C\frac{B(\varepsilon')}{B(\varepsilon)}(\varepsilon'^2 + 2\varepsilon')^{-(\gamma+1)/2}(\varepsilon+1)\exp(-\alpha D)\,d\varepsilon.$$

(Energy unit $= \mu c^2 = \sim 10^8$ eV.)

We have used this formula. It contains three parameters to be adjusted from experimental data: the normalization factor C, the exponent γ and α (corresponding to the mean life τ_0 of the meson). Each of these parameters appears linearly in the expression of $\log dN/d\varepsilon$, making it relatively easy to apply a least squares method to $\log dN/d\varepsilon$ and determine the parameters simultaneously.

The experimental data were those used by Jánossy and Wilson, namely, those of Blackett, Jones and Wilson, with the exclusion of the doubtful value near $\varepsilon = 1{\cdot}5 \times 10^{10}$ eV. To avoid giving a greater statistical weight to the high-energy region owing to the greater number of determinations, we averaged the experimental data, taking as experimental spectrum (normalized to maximum value 1):

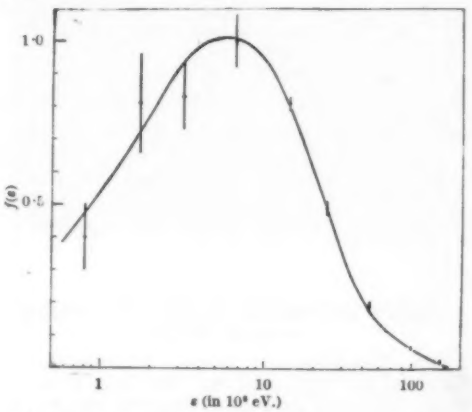
ε	$\frac{dN}{d\varepsilon}$	ε	$\frac{dN}{d\varepsilon}$
0·8	0·40	14·03	0·81
1·69	0·81	24·02	0·49
3·13	0·83	44·01	0·195
6·57	1·00	79·0	0·061

Application of the least squares method gives

$\gamma = 3{\cdot}20$, $\tau_0 = 1{\cdot}69 \times 10^{-6}$ sec., $C = 2{\cdot}67 \times 10^5$.

This seems to confirm that γ has a value somewhat higher than that usually accepted. The value of τ_0 seems rather small in comparison with the best experimental data, and it would have been even smaller had we used an initial $\varepsilon^{-\gamma}$ spectrum. It would be difficult, however, to draw any inference from this fact, owing to the uncertainty which still exists in the low-energy part of the spectrum.

The effect of a departure θ of the measured meson tracks from the vertical direction was also considered, but it was found that with a distribution of the form const. ($l\cos\theta - r\sin\theta$) valid for parallel counters of length l cm., placed r cm. apart from one another, no important errors should occur up to a maximum value of 30° for θ, which appears to be a reasonable upper limit.



The graph shows the accord between experimental data and theoretical curve.

M. Della Corte
T. F. Fazzini
S. A. Franchetti

Physical Institute,
University of Florence.
March 25.

[1] *Nature*, **158**, 450 (1946).
[2] *J. Franklin Inst.*, **236**, 9 (1943).
[3] *Ergeb. Exak. Naturwiss.*, 40 (1938).

Diffuse Bands on Laue Photographs of Silver Chloride Crystals

In a recent paper and in a communication in *Nature*[1], Laue photographs of large silver chloride crystals were published, showing diffuse bands and spots. It was then suggested that these bands were, at least partly, not of thermal origin, but due to the presence of definite lattice defects, parallel to the cubic planes and axes. The experimental fact that such crystals, when irradiated with ultra-violet light, showed an 'optical etching effect' parallel to the cubic planes (as evident from the reflexion of incident light by the irradiated crystals, which was similar to that shown by chemically etched crystals) was considered to support this conclusion. Moreover, on a photograph of a crystal cooled with liquid air, taken at the time the above paper was published, the diffuse pattern was still visible.

In view of the fact that in practically all other cases of diffuse bands published so far[2] they are temperature-dependent, it was worth while to make such photographs anew, now conditions for obtaining liquid air are again more favourable. These photographs show clearly that with silver chloride also the bands are of thermal nature, as they disappear practically completely at low temperatures. The apparently opposite effect obtained in the former experiment was probably due to insufficient cooling of the crystals. Diffuse bands due to lattice distortions of the type discussed in our note are thus, so far as known to us, not observed with certainty in any case[3]. The remarkable etching effect shown by the irradiated crystals remains, however, an indication that actually deviations parallel to cube planes are present in the crystals.

W. G. Burgers
Tan Koen Hiok
Laboratorium voor Physische Scheikunde
der Technische Hoogeschool,
Delft.
March 21.

[1] Burgers, W. G., and Tan Koen Hiok, *Physica*, **11**, 353 (1946); *Nature*, **157**, 19 (1946).
[2] Lonsdale, K., *Proc. Phys. Soc.*, **54**, 314 (1942).
[3] We are not discussing here such effects as are observed on photographs of age-hardening crystals (Preston, G. D., *J. Sci. Instr.*, **18**, 155 (1941)), of asbestos crystals and the like (cf. Guinier, A. J., *Proc. Phys. Soc.*, **57**, 310; 1945) and also the 'extra reflexions', observed with special diamonds, the exact nature of which seems not to be precisely known (Lonsdale, K., *loc. cit.*; Lonsdale, K., and Smith, H., *Nature*, **148**, 112, 257 (1941); also Guinier, A. J., *loc. cit.*).

X-Ray Diffraction Studies of Yielding in Mild Steel

The distribution of plastic deformation in a cold-stretched mild steel bar has been studied by X-ray diffraction methods. Using the back-reflexion technique with cobalt radiation, two spotty rings were obtained by reflexion of the $K\alpha$ doublet from the (310) plane of iron. Plastic deformation in the specimen was indicated by a blurring of the spots of the diffraction pattern as the individual crystals, which gave the reflexions, became distorted. An X-ray beam of about 1 mm. diameter was used to explore the distribution of the deformation.

A normalized, 0·26 per cent carbon steel bar was stretched in a tensile testing machine until the so-called 'Lüders lines' or 'Hartmann bands' appeared over part of its length. These Lüders lines are parallel strain bands, inclined at approximately 45° to the bar axis, and made visible by the flaking-off, along the bands, of the oxide scale produced by the normalizing process. The average plastic extension within the region showing Lüders lines was found from gauge marks to be about 1·5 per cent.

Fig. 1 represents a section of the bar including part of a region of strain markings. Figs. 2 *a–d* show portions of X-ray patterns obtained from the particular areas of the bar indicated in Fig. 1. In each case the chosen area was first etched with nitric acid to remove the oxide layer.

The pattern, Fig. 2 *a*, was obtained from an area within a region showing no strain markings. The sharpness of all but a few of the spots indicates that only slight plastic deformation occurred in this region. In the pattern, Fig. 2 *b*, obtained by directing the X-ray beam on a Lüders line (that is, on a band from which scale had peeled) almost all spots are diffuse, indicating marked plastic deformation.

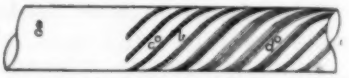


Fig. 1. Portion of a stretched steel bar, showing part of a region of Lüders lines

Fig. 2. X-ray diffraction rings obtained by back-reflexion from points *a*, *b*, *c*, *d* of Fig. 1

Figs. 2 *c* and *d* illustrate patterns obtained from areas lying between two Lüders lines. For such areas chosen near the boundary of a region showing the strain bands, only a few of the spot reflexions are blurred, as in Fig. 2 *c*. However, in patterns such as Fig. 2 *d*, from such areas chosen near the centre of a region of Lüders lines, a greater proportion of the spots are blurred, although the blurring is still less extensive than in Fig. 2 *b*.

Since the region of Lüders lines grows as a bar is stretched, these results show that the amount of plastic deformation is much greater between Lüders lines formed at an early stage of the stretching than between those formed later, and is very slight between the most recently formed lines. These observations lead to a picture of the mode of yielding in mild steel similar to that proposed by Jevons[1]. At first a narrow band of material at about 45° to the axis of the bar undergoes plastic strain of the order of 2 per cent. With increased stress, other such bands, separated by regions of very little deformation, appear at successive intervals along the bar. As the region of strain-bands grows by the formation of new bands, the earlier formed lines grow laterally by an increase in plastic distortion on either side. Thus the distribution of plastic deformation becomes more uniform, and eventually the whole bar undergoes plastic strain of the order of 2 per cent.

The variation of deformation across a set of Lüders lines may be demonstrated readily by the use of an X-ray beam diverging from a point source through a long slit. A strip of the specimen at right-angles to the lines is irradiated, and gives diffraction rings broadened along their diameter parallel to the strip. Across the broadened portion of the rings, the spots are alternately sharp and diffuse, corresponding to the alternation of plastically deformed and undeformed regions along the irradiated strip. Good resolution may be obtained by a suitable choice of radiation.

J. M. Cowley
Division of Industrial Chemistry,
M. S. Paterson
Division of Aeronautics,
Council for Scientific and Industrial Research,
Melbourne. March 31.

[1] Jevons, J. D., "The Metallurgy of Deep Drawing and Pressing", Chapter 7 (1940).

Recrystallization of Duplex Brass

ALTHOUGH the deformation and subsequent recrystallization of pure metals and single-phase alloys has been widely studied, little work has been done on the deformation of duplex alloys, that is, alloys containing two phases, and we know of no published work on their behaviour on annealing after cold work. The two phases will normally possess quite different physical properties. On application of a stress, the phase with the lower elastic limit will be plastically deformed at a lower stress, and the distribution of the deformation in the two phases will depend on their relative elastic limits and work-hardening characteristics. Recrystallization in the two phases can be expected to occur after different total deformations and at different temperatures, not only because of their different chemical compositions, but also because of the different extents to which deformation occurs in the crystals of the two phases.

The progress of recrystallization was studied in a duplex brass (60 per cent copper, 40 per cent zinc), the most familiar example of an alloy containing two deformable phases. The recrystallization was followed in two ways, namely, by the metallographic technique of electrolytic polishing, etching and microscopic examination, and by an X-ray diffraction method. From the character of the lines of the two phases which appear on the one diagram, the state of deformation or recrystallization can be assessed (see Fig. 1). Figs. 2 and 3 are photomicrographs which illustrate how recrystallization of the two phases can be distinguished metallographically. In all experiments there was a good agreement between the results obtained by microscopic examination and by the X-ray method.

A series of specimens was prepared from the gauge lengths of tensile specimens which had been strained by different amounts and then annealed. Some of the results obtained are summarized in the accompanying table. It is clear that the α-phase tends to recrystallize at lower temperatures and at lower deformations than the β-phase. This is to be expected, because the α-phase is softer and more readily deformed than the β-phase.

RECRYSTALLIZATION IN THE PHASES OF DUPLEX BRASS

% Elongation	Phases	State of recrystallization after annealing at			
		400° C.	425° C.	450° C.	500° C.
36	α	partly	fully	fully	fully
	β	none	partly	fully	fully
30	α	partly	fully	fully	—
	β	none	commenced	partly	
24	α	partly	partly	fully	fully
	β	none	none	partly	fully
18	α	none	just comm.	commenced	—
	β	none	none	none	

To determine the effect of the relative quantities of the two phases on recrystallization, specimens of brass wire (40 per cent zinc) were quenched from 750°, 650° and 550° C. respectively, thus producing alloys containing approximately 80, 50 and 30 per cent of the β-phase. Wire-drawing was employed as a means of deformation, since a greater amount of deformation could be imposed on the alloy than in a tensile test. The wires were cold drawn from 0·186 in. to 0·073 in. (85 per cent reduction in area), and specimens annealed at 300°, 350°, 400° and 450° C. for half an hour. There was a general tendency for the β-phase to recrystallize to a larger extent in the alloy containing the least quantity of the β-phase.

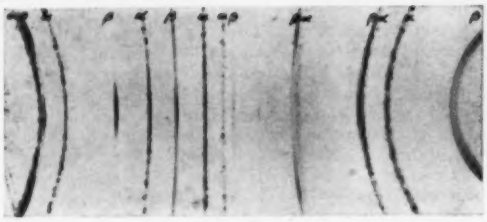


Fig. 1. X-RAY POWDER PHOTOGRAPH OF AN α-β BRASS SPECIMEN. THE α-PHASE IS NEARLY FULLY RECRYSTALLIZED, WHILE THE β-PHASE IS STILL DEFORMED

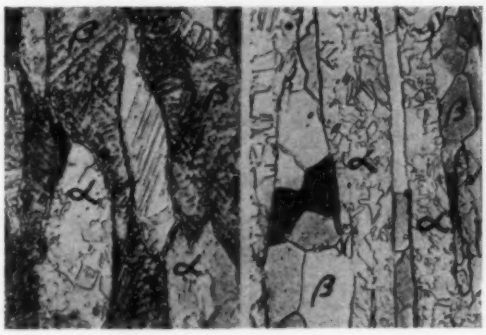


Fig. 2 Fig. 3

Fig. 2. SPECIMEN IN WHICH THE α-PHASE IS PARTLY RECRYSTALLIZED; THE β-PHASE IS STILL DEFORMED

Fig. 3. SPECIMEN IN WHICH BOTH PHASES HAVE FULLY RECRYSTALLIZED

Photomicrographs × *c.* 400

For example, on annealing at 400° C., the β-phase in the 80 per cent β-alloy had just commenced to recrystallize; it was partly recrystallized in the 50 per cent alloy; and fully recrystallized in the 30 per cent alloy. A β-crystal will take part in the deformation to a larger extent when it is embedded in a matrix of soft α-crystals than when it has many hard β-crystals as neighbours. Consequently recrystallization will take place at lower temperatures in the former case.

In all the experiments described above, the crystals of the α-phase recrystallized before those of the β-phase. However, the β-phase commenced to recrystallize *before* the α-phase in a series of experiments where the original wire was air-cooled from 800° C., drawn to 85 per cent reduction in area and specimens annealed in the usual way. At 250° C. the β-phase had partly recrystallized, whereas the α-phase was still deformed. The composition and the relative proportions of the two phases were similar to those in alloys used previously. The only difference between this series and the other series was that these alloys had been *air-cooled* from 800° C., whereas the other alloys had been *water-quenched*. This suggested that a change in properties as a result of the order-disorder transformation might be responsible for the reversal in the sequence of nucleation.

To test this theory, two pieces of brass wire were annealed at 800° C., then slowly cooled. The first specimen was water-quenched from 475° C. (that is, just above the critical temperature of the order-disorder transformation), while the other was quenched from 400° C. (just below the critical temperature). Both wires were then drawn as in the

other experiments, and specimens were annealed. X-ray and microscopic examination revealed that, in the wire quenched from *below* the critical temperature, the β-phase had partly recrystallized at 250° C., while the α-phase was still completely deformed. In the other wire, the α-phase commenced to recrystallize at 275° C., whereas the β-phase did not start to recrystallize until 300° C.

Thus the behaviour of duplex brass on annealing after deformation is quite complex. Order-disorder transformations do not, of course, occur in all alloys, but the effect of the relative proportions of the two phases is of general application. It is also evident that consideration must be given to the slope of the phase boundaries, for changes in composition of a phase will have some influence on its behaviour during recrystallization.

R. W. K. Honeycombe
W. Boas
Section of Tribophysics,
Council for Scientific and Industrial Research,
University of Melbourne.
March 31.

The Harmonic Cord

While the possibility of vibrating a thin cord regularly in a flat plane from a tuning fork has long been known as the 'Meldé cord', from its discoverer; and the development of large cigar-shaped loops on a thick stretched cord, corresponding to the fundamental and harmonic frequencies, by variable-speed electric-motor drive adjusted to the natural periods of the cord, has followed as a physical laboratory demonstration; it is not generally realized that a multiplicity of frequencies may be simultaneously developed on the same cord, by suitably designed mechanisms.

When two or more rotary vibrations having harmonic relations are superposed, stable figures may be produced alike for concurrent or opposed rotations, often very beautiful in form. The section at any position on the cord, which may be called the 'orbit' at that position, will be a trochoidal figure, twin or multiple elliptic if elliptic instead of circular rotations are imposed. The complete enclosing figure, which may be called the 'envelope', may have internal or external 'cells', corresponding to the internal or external loops of concurrent or opposed rotation trochoidal curves developed with the harmonic relationships chosen.

If two rotations which are not perfectly tuned to a harmonic relation are superposed, the whole envelope will rotate slowly for a small tuning error, and rapidly for a large one; while the evolution of form as a second vibration is impressed on an existing fundamental or harmonic vibration envelope is very fascinating to watch.

Where two rotations in the same direction and with nearly related frequencies such as 9 : 10 are superposed, the cord appears to pulse rapidly longitudinally as the addition and subtraction of amplitudes alternately occur; sometimes apparently similar effects may be noted temporarily while tuning other frequencies together.

A high harmonic of small amplitudes may be superposed on large fundamental or low harmonic cigar-shaped envelopes, and may produce a remarkable ripple effect on these surfaces, probably rotating over them.

With elliptic rotations there appears to be a pronounced tendency towards circularity, apparently by transference of energy between the two octave-related vibrations involved, as is readily seen when an elliptic drive is given to the cord. However, an interesting elliptic case is a circular drive at a considerable angle to the axis of the cord, so superposing a longitudinal wave on the transverse wave in a circular envelope system, and in effect producing an elliptic rotation; this produces an envelope which contains various octave orbits (but not accurately in planes normal to the cord axis) which may rotate slowly and show interesting cell and phase changes as it does so.

If rectilinear vibrations in different planes are impressed on the cord, the orbits are Lissajous figures; the cells and envelope forms evolving with change of phase relationships if the tuning is imperfect, no rotation of the envelope occurring in this case.

Up to the present, no facilities for the difficult photography of this figuring have been available; and sketching does not adequately or accurately record the complex and transparent forms which can be seen. It may be noted that musical instrument strings show similar orbits on a microscopic scale, as was first demonstrated by me in 1911, but with the figuring so slim that the beauty of the envelope forms could not be appreciated.

Cyril H. H. Franklin
50 Wooley Hill, Selly Oak,
Birmingham.

Mortality Required to Prevent Population Increase

Biologists have often calculated the vast numbers which would be reached in a relatively short period by the descendants of a single pair of insects or other fecund animals if all of them reproduced at the normal rate before dying. Such calculations are used to illustrate the high potential rates of population increase, or the severity of the natural checks to increase, or to show the very high mortality required to keep a fecund population within normal limits. It should, of course, be recognized that, in many cases, reductions in the rates of reproduction and development also play an important part in limiting increase. However, the purpose of this note is to direct attention to the fact that, in certain calculations of the 'necessary mortality', there is a striking fallacy.

An example may be taken from a paper by Payne[1] on the ecology of *Microbracon hebetor* Say and its host, *Ephestia kühniella* Zeller. The latter has "a total period from egg-laying to egg-laying of 62 days at 32° C., with 52·5 % of the adults females, and the number of eggs per female 181. The offspring from one female at the end of a year is 30,428,590,122 counting five generations to a year. The percentage that must die to keep the number constant is 99·99999999993." The astronomical size of these figures is due to the assumption that there is no mortality of offspring before reproduction, until the fifth generation, an unlikely event with most animals and certainly unrealistic in the case of *Ephestia*. If we make the more natural assumption that the mortality is the same in each generation, the surplus offspring per female in each generation is approximately 179, or $179 \times 5 = 895$ in five generations; to eliminate this surplus a mortality of less than 99 per cent in each generation is sufficient.

The origin of the misconception is apparently in a method developed by Bremer[2]. Considering an insect population of n individuals, of which a constant proportion n/b are females, each of which lays a eggs and then dies, Bremer expressed the proportion of the offspring that must be destroyed, in order to keep the number down to n, as $na/b - n$, or $n\,(a/b - 1)$. He called $a/b - 1$ the "normal coefficient of destruction", that is, the necessary mortality of offspring as a multiple of n. He also expressed this necessary mortality as a proportion of the number of offspring, calling this value the "normal destruction quotient", which is $n\,(a/b - 1)/na/b = 1 - b/a$. This is correct. Bremer then expressed the "normal coefficient of destruction" for a year, in which there are c generations, as $a^c/b^c - 1$, and the corresponding "normal destruction quotient" as

$$q_c = 1 - b^c/a^c. \qquad (1)$$

Both these formulæ imply that there is no mortality (except the death of adults after reproducing) for c generations.

Bremer's formula (1), and his correspondingly fallacious numerical example, were quoted by Blunck[3], and from him by Uvarov[4]. Both these authors called q_c the *coefficient* of destruction. Payne[1] also followed Blunck in confusing the coefficient and the quotient; moreover, the formula (1) is misquoted in her paper, but clearly she did not use it in that form.

Since the above error occurs in papers of some importance to insect population studies, it is desirable that it should be pointed out. If the method is to be used for periods embracing more than one generation, it is best to assume the same rate of mortality in each generation. Then the 'coefficient' will be $a/b - 1$ and the 'quotient' will be $1 - b/a$, whether one or many generations are involved. When such regular mortality cannot be assumed, the method is applicable only to single generations.

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M. E. Solomon
Department of Scientific and Industrial Research,
Pest Infestation Laboratory,
Slough, Bucks.
March 21.

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[2] Bremer, H., *Z. angew. Entom.*, **14**, 254 (1929).
[3] Blunck, H., *Z. Pflanzenbr.*, **39**, 1 (1929).
[4] Uvarov, B. P., *Trans. Ent. Soc. Lond.*, **79**, 1 (1931).

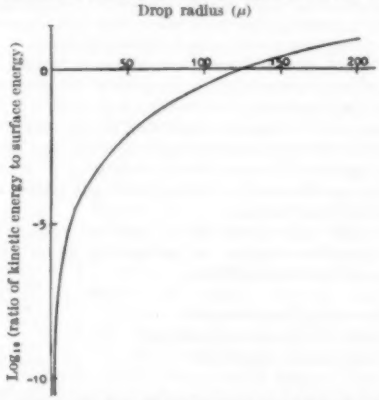
Collisions of Cloud Droplets

Whether cloud droplets coalesce on impact is a problem of obvious theoretical and practical interest, having bearings on theories of rain formation, methods of fog dispersal, the stability of clouds, etc. A major obstacle in the way of providing an answer to this question is the difficulty of simulating in the laboratory the conditions that obtain naturally in clouds. Nevertheless, in July 1941, I made some experiments in connexion with this subject at the Imperial College with the aid of facilities kindly provided by Prof. (now Sir George) Thomson, and with the help of Dr. J. Mazur, and the results obtained may be of interest to others concerned with the same problem.

The liquids used were pure water, fluess oil, absolute alcohol, α-chloro-naphthalene and benzene, these liquids being chosen for their widely differing physical properties. The drops were produced by spraying from an atomizer, and their behaviour in a small draught-proof chamber was observed through a microscope by light reflected from their surfaces. The outstanding result of the experiments was that droplets were never seen to coalesce on impact, neither when there were 'head-on' collisions nor when the drops, which were found to carry both kinds of electric charge (presumably due to their method of production), were made to collide more violently by applying an electric field. In all, the behaviour of many hundreds of droplets of each liquid was observed. Unfortunately, the apparatus limited careful observation to drops up to 2 μ radius, and this is less than the size that occurs most frequently in clouds. However, if the following explanation of the non-coalescence of these minute drops is correct, it may be inferred that cloud droplets may not coalesce on impact until they are much larger than this—probably greater than 50 μ radius, which is the size of drizzle drops.

Two small drops will separately assume the shape of minimum surface energy, a sphere. If they coalesce, the joint drop will again be a sphere in which the surface energy has a new and lesser minimum. During amalgamation, the drops will be distorted, and, though the mechanics of coalescence are not known, the distortion may cause an increase in surface energy. Such an increase of surface energy, though it would be small compared with the total, would constitute a barrier to coalescence: if it is overcome, the drops will amalgamate; if not, they will rebound. In this experiment the only mechanical energy available to overcome such a barrier was the kinetic energy of the drops, due either to fall under gravity or the electric field, and, unless this energy is comparable with the possible increase in surface energy due to distortion, amalgamation cannot take place. The graph shows how, for a water drop, the ratio of the kinetic energy at terminal velocity to surface energy varies with the drop size.

It is clear that the kinetic energy is quite insignificant for very small drops, and even at 50 μ radius the ratio is only 0·01. It is true that collisions between drops of different sizes are more likely than between drops of the same size; but in such cases the kinetic energy destroyed on impact will be much nearer that of the smaller drop. Hence, small as it is in comparison with the surface energy of the latter, it will be even more insignificant compared with that of



Ratio of kinetic energy at terminal velocity to surface energy as a function of size of drop

the larger drop, and coalescence is unlikely both for impact of small drops and for large drops with small ones. In this connexion it is of interest to record that when a large drop was formed in the experiments, it plunged through the chamber scattering the smaller ones in its path.

I am indebted to the director of the Meteorological Office for permission to communicate this letter.

W. C. SWINBANK

Meteorological Office, Air Ministry,
Dunstable, Bedfordshire.
April 15.

Silver Chloride Plates for Infra-Red Spectroscopy

ALTHOUGH rock salt has been commonly used in the construction of absorption cells for infra-red spectroscopy, it has the inherent disadvantages of being opaque beyond 15 μ, and of being attacked by water. Silver chloride, however, is transparent up to 25 μ and is completely resistant to water.

Fugassi and McKinney[1] have briefly described a method for making silver chloride plates by rolling the fused material. Difficulties were encountered in rolling and casting when trying to repeat this work. Silver chloride plates of suitable quality, however, were prepared in this laboratory by the following method.

All operations were carried out in a darkened room lit by a 40-watt bulb. Silver chloride was precipitated from silver nitrate and sodium chloride, taking care that as little silver nitrate as possible was occluded in the precipitate. The latter was filtered off and dried at 105° C. A piece of porous porcelain (2 in. × 2 in. × $\frac{1}{2}$ in.) was heated to redness over a Bunsen burner, and a few grams of the dry silver chloride melted on (melting point AgCl, 455° C.). The orange liquid was spread out in a layer about $\frac{1}{2}$-mm. thick, and any scum scraped to the side using a second piece of porcelain. When cold, the sea-green layer was covered with a film of nitrocellulose lacquer and the whole immersed in a 20 per cent solution of sodium thiosulphate for 15–20 min., after which time the opalescent silver chloride layer could be peeled off the porcelain.

After washing the silver chloride in acetone, it was pressed between polished stainless steel disks in a steam-heated press at 4 tons per square inch for 2-min. periods. The plates so produced were stood in gaseous chlorine for a number of hours, in order to ensure complete clarity, and then repressed.

This method provides silver chloride plates about $\frac{1}{2}$-mm. thick, transmitting uniformly 65 per cent of the incident radiation between 5 μ and 15 μ—the region studied. They are rigid and tough and suitable for the construction of absorption cells, and are only slowly darkened on exposure to daylight. Artificial light had no detectable influence on the plates over a period of four weeks.

Kremers[2] has described a method, based on a silver sulphide coating, of protecting silver chloride plates against solarization.

K. S. TETLOW

Research Department,
I.C.I. Ltd., Explosives Division,
Stevenston, Ayrshire.
April 7.

[1] Fugassi and McKinney, *Rev. Sci. Instr.*, **13**, 335 (1942).
[2] Kremers, *J. Opt. Soc. Amer.*, **35**, 349 (1946). See also Fuoss, *Rev. Sci. Instr.*, **16**, 154 (1945).

Distortion of Fungal Hyphæ in the Presence of Certain Inhibitors

Brian, Curtis and Hemming[1] have recently reported the production by *Penicillium Janczewskii* of a factor having little antibiotic action but causing characteristic distortion of fungal hyphæ growing in its presence. This substance, isolated in a crystalline state and given the formula $C_{20}H_{30}O_9$ [2], has been termed 'curling factor'. The description and illustrations of the stunting and curling caused by this factor are strongly reminiscent of the appearance of hyphal tips growing in the presence of a number of relatively simple inhibitory substances (notably methyl *p*-hydroxybenzoate[3]) encountered by me during the course of fungistatic investigations using *Aspergillus niger*, *Penicillium roqueforti* and *Byssochlamys fulva*. Brian, Curtis and Hemming, while referring to earlier records of similar morphological effects caused by the metabolic products of organisms, consider their effect to be distinct from any previously described for pure chemicals. I consider that the behaviour of the esters referred to above is likely to come into the same class of phenomenon as claimed for 'curling factor'.

My investigations have involved hyphæ growing on Czapek's agar (*p*H 4–5; nitrogen as nitrate), and, although records of distortion have been incidental to the principal purpose of the work, certain aspects seem to merit comment. The appearance of affected hyphæ is most characteristic, involving stunting, multiple branching and curling in a peculiar zigzag form. That the phenomenon is not directly associated with the inhibitory action of the substance is seen in a comparison of homologous esters, where increasing chain-length, although markedly increasing fungistatic activity[4], does not proportionately enhance the distortion effect. On the basis of concentration of ester causing a given level of inhibition, the lowest esters, notably methyl, cause much greater distortion. As a result, little, if any, curling of hyphæ is to be seen with those concentrations of higher esters (such as butyl to heptyl) that are low enough to permit growth. Distortion has also been observed for anisic, salicylic and benzoic acids and for phenol; with *p*-hydroxybenzoic acid itself and the *m*-isomer, the effect is either small or absent.

It is of interest to examine the quantitative nature of the relationship. Brian *et al.* have found their 'curling factor' to be remarkably active, permitting marked stunting at 6×10^{-6} molar. In contrast, the molar concentration of methyl *p*-hydroxybenzoate, permitting ready detection of the similar effect with *A. niger*, is of the order 300×10^{-6}—still very much less, however, than that required for the complete inhibition of growth (approx. $3{,}000 \times 10^{-6}$). It is, of course, possible that distortion results not directly from the action of the inhibitor but from a product of the mould's own metabolism with inhibitor serving as precursor. If this were so, the concentration of such a factor might well be very much less than that of the inhibitor initially supplied.

J. M. VINCENT

School of Agriculture,
University of Sydney.
March 19.

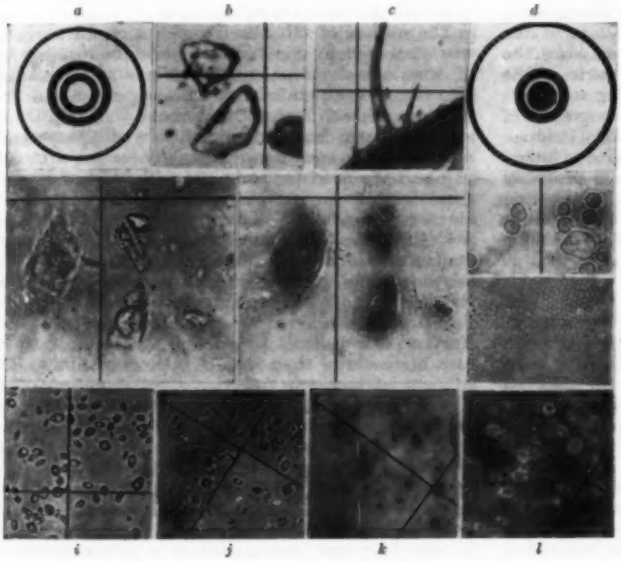
[1] Brian, P. W., Curtis, P. J., and Hemming, H. G., *Trans. Brit. Mycol. Soc.*, **29**, 173 (1946).
[2] McGowan, J. C., *Trans. Brit. Mycol. Soc.*, **29**, 188 (1946).
[3] Vincent, J. M., *J. Soc. Chem. Ind.*, in the press.
[4] Cavill, G. W. K., and Vincent, J. M., *J. Soc. Chem. Ind.*, in the press.

PRODUCTION OF CONTRAST IN THE MICROSCOPE IMAGE BY MEANS OF OPAQUE DIAPHRAGMS

By Dr. A. F. HALLIMOND
Geological Survey and Museum

'PHASE-CONTRAST' methods have recently been widely used to improve the visibility of small transparent objects. The illumination is restricted to a narrow cone by means of an annular diaphragm placed under the condenser, and the direct beam passes through a conjugate annular 'phase-plate' near the upper principal focus of the objective. A theoretical explanation of the effect was given in the original paper by Zernike. It appears to me, however, that Zernike's explanation is insufficient through the omission of an important physical factor, which seems to have been only partly recognized in the later paper by Kohler and Loos. "The details of such an object (transparent) are distinguished only by unequal thickness or refractive index, i.e., they impose on the incident light only phase differences." This statement by Zernike ignores the effect of the inclination of the surfaces that is in fact nearly always present. Methods which render inclined surfaces visible have long been employed by mineralogists for refractive index determination by the Becke line and Schroeder effect. The accompanying photographs (*a–l*) suggest that useful contrast may be obtained by an arrangement of opaque stops, without the use of a 'phase-plate'. It may perhaps be convenient to use the term 'stop-contrast' to distinguish this method from that involving the use of the phase-plate.

In phase-contrast, if a given 'point' in the object is to be regarded as an element of a prism rather than as a horizontal surface, the corresponding image of the condenser annulus at the back of the objective will appear as a circle which no longer coincides completely with the annular phase-plate. Part of the 'direct' beam then reaches the eyepiece in differing phase from that which may still traverse the phase-plate, and the image is consequently weakened by interference. By adjusting the opacity of the phase-plate, the amount of light in the two parts of the beam can be matched so as to produce maximum interference. Such an explanation would seem to account for many of the results obtained by phase-contrast, though the full range of these effects has scarcely yet been investigated. The interference method is very efficient in extinguishing the light, but it is open to the objection that when the phase-plate has been adjusted to give maximum contrast for a certain small angular deviation, the more deviated light from other points in the object will mainly miss the phase-plate and will not be extinguished. In such cases an opaque diaphragm may give a wider range of extinction.



a. Contrast diaphragm at the back focal plane of the 25 mm. objective used for *b*, *c*.
b. Objective 25 mm. with contrast diaphragm *a* above the objective. Quartz grain in oil of index about 1·55, refractive index difference about 0·01. The steep edges are dark and the rest shaded according to the inclination of the concholdal surface. × 36.
c. As in *b*. A leaf-hair in water. There is little injury to the definition. × 36.
d. Contrast diaphragm at back of 4 mm. objective used for *f*, *g*, *h*, *j*, *k*, *l*.
e. 4 mm. 0·85 N.A., *no diaphragm above objective*, the condenser giving ordinary conical illumination. Scales and rouleaux of kaolinite in balsam, refractive index difference about 0·020. Detail is clear with marked Becke lines, but there is little contrast with the background. × 300.
f. 4 mm. 0·65 N.A., contrast diaphragm above the objective as *d*, etc. Detail is still clear, but there is now a marked contrast with the background. × 300.
g. As in *f*. Red and white blood corpuscles. × 300.
h. As in *f*. Diatomite in liquid of refractive index 1·39. × 300.
i. 4 mm. 0·85 N.A., *no diaphragm above the objective*, ordinary conical illumination as in *e*. Yeast in water. Some of the cells in these photos have moved during the exposures. × 300.
j. 4 mm. 0·65 N.A., contrast diaphragm above the objective as in *f*, etc. Yeast is rather strongly refractive and there is little addition to the detail already visible in *i*. No injury to definition.
k. As in *j*. The outer zone of the contrast diaphragm *d* has been covered so that only the direct beam through the annulus is being used. There is considerable loss of definition, the focus in this case being very deep.
l. As in *j*. The annulus has been covered so that only the outer zone of the contrast diaphragm *d* is being used. This gives in effect a 'dark ground' illumination, and the image chiefly consists of bright lines due to the steep edges of the cells.

Stop-contrast is obtained by using a narrow annular opening below the condenser (in the present case a lens of about 1½ in. focal length), with a conjugate annular opening near the upper principal focus of the objective. Light deviated by the object is eliminated by surrounding the open annulus at the objective with an opaque diaphragm, which in its simplest form might cover the rest of the objective. Such an arrangement is, however, inadmissible since it reduces the aperture and damages the resolving power (photo. *k*). The opaque part of the stop must therefore be usually limited to a certain angular distance immediately on each side of the annulus (*a*). It is sometimes convenient to darken the whole of the relatively small central area (*d*). With a complete stop, practically all the deviated light contributing to the Becke and Schroeder effects would be eliminated. With the dark annuli some extremely deviated rays will still get through the open

outer zone, so that steep edges and objects of high refractive index difference may still show a modified Becke line; but the desired object may be practically free from it, dark contrast being produced instead.

The following incomplete statement indicates the angular values concerned. The maximum deviation that can be produced by a cylindrical object is that for a ray entering and emerging at the grazing angle and will equal $2(90-\theta)°$, where θ is the critical angle. For refractive indices 1·33 (water) and, say, 1·35 (object), $2(90-\theta)$ is 20° in the liquid. If the opaque part of the diaphragm at the back of the objective intercepts rays that occupy this angle, such an object will appear dark except at points near the centre. For low-power objectives with low numerical aperture, the angles that can be covered are much narrower than this, but the method will be sensitive to small differences in refractive index. Higher powers, on the other hand, with numerical aperture about 1·0, will accommodate annuli covering a wider angle that may approach 20°, and they can be made effective for objects of wider deviation.

The accompanying photographs illustrate the results obtainable with low- and medium-power objectives (Cooke, 25 mm., 0·15 N.A. and 4 mm. N.A. 0·65), by means of narrow conical illumination with opaque stops partly covering the back of the objective as shown in *a* and *d*. In these cases the depth of focus is very small and only parts of the object can be in focus, the tendency being to obtain an 'optical section'. Phase-contrast photographs of kaolin were reproduced in *Nature*, **158**, 621 (1946).

The comparison photographs *e* and *i* were taken with narrow conical illumination. This is probably the most satisfactory form of ordinary illumination for objects of small refractive index difference, since it gives a moderate Becke effect without undue loss of light, but the image is mainly due to this effect.

Photographs *c*, *f*, *g*, *h*, *j* indicate that the contrast diaphragm causes no great injury to the resolution of details in the object. *k* and *l* were taken through the annulus and outer zone of the objective, used separately. Neither would supply the detail observed in *j*, although the only difference is that in *j* both areas are open simultaneously. The improvement is presumably due to interference in accordance with Abbe theory.

In ordinary narrow-aperture illumination, a small object in liquid of lower refractive index appears light when the tube is raised, almost invisible when in the focal plane, and dark when the tube is lowered. For a simple isolated object the latter effect resembles that given by contrast methods, but is only produced when the object is somewhat out of focus. When the object is in the focal plane, the use of a contrast diaphragm produces a similar darkening, and the details are in focus. For a complex rugose (or finely granular) object such as the kaolin scales in *e*, the Becke lines overlap in the interior of the object areas, producing a confused mottling which in fact only an experienced observer would interpret as due to a solid object. It is in such cases that the use of contrast methods seems most likely to be advantageous.

The annulus in *d* was purposely made narrow to test the effect on resolution. It is not suggested that this would be necessary in all cases.

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INDUSTRY AND RESEARCH IN THE SHEFFIELD AREA

THE Federation of British Industries has been holding in recent months a series of conferences on that vital question of the present time, the dependence of progressive industry on research. One of these regional conferences was held in Sheffield on June 5 to discuss the bearing of research on industry in the case of the smaller manufacturing concerns. The problems were considered from two aspects: the first, at a morning session, presided over by Sir Walter Benton Jones, dealt with the part research could play in promoting industrial efficiency, exports and a higher standard of living, with special reference to the industrial problems of the Sheffield area. Sir Walter, in opening the meeting, directed attention to the valuable conclusions of previous conferences, and stated that industry values highly the growth of special research. The afternoon session, Lord Dudley Gordon being in the chair, was devoted to the case of the smaller manufacturing concern which could not afford the cost of a research department, and consideration was given to the research organisations and facilities which could serve it.

The subject of "Research and National Recovery" was discussed by Sir William Larke in a paper full of wise advice of an encouraging and stimulating character. He pointed out that our industrial production needs to be increased above that of 1938 by at least 25 per cent under conditions of a shortage of raw materials and man-power. These requirements point to the need for technical advances, at least as great as those which were achieved during the War. He regards shortage of coal as the principal factor preventing our economic recovery. This difficulty demands still more attention to efficient use, by increased supervision, by continuing to demand of the suppliers fuel of the appropriate quality, and by the provision of more efficient fuel-using plant. Further, our general production efficiency must be at a higher level than that of our competitors. The support of research and closer collaboration of all elements concerned with industry and research are necessary. A survey made by the Federation of British Industries of research activities in British industry has shown a total of some 40,000 staff, of whom 10,000 are graduates of a university or equivalent standard. The total expenditure by industry on research, Sir William said, has increased fourfold in the last ten years, and is now in excess of £25,000,000 per annum, or at least 0·5 per cent of the total value of our annual industrial production. This situation and the potentialities of rapid application of the results of research and discovery to the improvement of industrial efficiency should provide the means of strengthening our competitive power in world markets. The achievements in the face of the overwhelming difficulties of 1940 onwards give hopes of inspiration and encouragement for the future.

Dr. G. P. Jones, discussing the lessons of history in a paper entitled "The Historical Growth and Economic Development of Sheffield Industries", had perforce to limit his scope to steel-making and cutlery. He showed how much we are dependent on the competence of our forefathers, and in what degree an easy livelihood and survival of two terrible wars are owed to their efforts. The historical aspects of the question were also dealt with by Lord Dudley Gordon in reference to valuable contributions

to industry which had been made by Sheffield metallurgists. These contributions, as it was put by Sir Charles Goodeve in his summing up of the discussion, showed that confidence is restored by the existence of a momentum of the past.

Prof. R. J. Sarjant, in a paper on "The Industrial Problems of the Sheffield Area and their Solution by Methods of Research", showed how complex the research problems of industry are becoming with the rapid advancement of engineering practice. While the laboratory is still the place for pioneer development, modern research has to proceed to the study of the maze of variables encountered in the plant. This entails the service of the balanced research team —trained research workers, observers and technicians—which in general can only be supplied by the larger research organisation, and in regard to the smaller firm can only be provided by co-operative action. The major problem at present appears to be the better utilization of existing resources. This involves co-ordination of effort, better training and adequate contacts between industrial and research personnel. There is, too, the place of the university, which is, so to speak, on the doorstep. Its function is to inspire the spirit of a 'divine discontent' so useful to research-mindedness, to foster the development of methods which apply to the solution of sociological and technical problems, and to be at the spear-point of the development of research.

Lord Dudley Gordon referred to the potentialities which lie in the institution of the Engineering Research Board. It is patent that demand for men, buildings and equipment has outstripped the supply. It is accordingly expedient to examine what can be done in the circumstances. Where there is no research department, there should be individuals who can collect and study new knowledge, and apply the findings of research done by others to immediate industrial problems. Internal questions of the attitude of management, psychological outlook and methods of organisation must be considered. There are valuable assets in the technical colleges, the scientific societies and advisory services to put inquirers in touch with sources of information. The Research Secretariat which the Federation of British Industries has set up is a valuable instrument in this last respect.

In a paper on "Sheffield Research Organisations, Facilities and Activities", Dr. W. J. Rees outlined the activities of the University, its functions and contributions in relation to the matters discussed, the achievements of the works' laboratories, the wide extent of the work of the research associations, and the facilities available in the technical industries and the efficient library services.

Dr. F. C. Lea finally tackled the main problem of the smaller firms, in a paper entitled "The Smaller Firm and its Application of Research". He took the view that of necessity the small firms have a real live interest in research; they have an essential place in the industrial structure; they can be helped and they can help themselves. The first essential is the need for adequate scientific and technical training of owners and managers. This means better technical colleges and more use to be made of them. These should be provided with staff and equipment to assist in solving the problems of the small firm. Managers should be familiar with what is being done not only in Great Britain but also in other countries. They should be ready, too, to buy new plant and to use new methods.

In the discussion which followed, many points of interest were raised, particularly around the matter of the fear which some managements have of admitting competitors to see what are considered to be secret processes. It was shown, however, that such fears are groundless, and that more is to be gained by accepting the opportunity of learning from others; the competitor usually already knows all about the 'secret' process. Dr. Maddocks referred to the high proportion of trained metallurgists who are being taken into the Armed Services, when industry requires them so urgently, and pressed that something should be done to remedy the position. Prof. Moore emphasized the need for 'putting over' the results of research; he rates it the major part of the problem. Finally, Mr. O. S. Brown, of the Department of Scientific and Industrial Research, outlined the many ways in which the Department is assisting in these matters. Thus help is always available for research in universities for "work of timeliness and promise". An information service has been set up to bring together the man with the problem and the man who can supply the solution. The aims are to create an organisation which is flexible and able to meet the varying needs of industry, to look for the gaps in the organisation and to consider how they can be filled.

In his summing up of the discussion, Sir Charles Goodeve hoped that the Federation would stimulate the examination of the questions discussed. Co-operative action, he said, is clearly called for, as well as more exertion. Much depends upon the technical knowledge of those in executive positions, since they must have sound discrimination in making their important decisions. The small firms may be facing a challenge greater than they have to-day. They should seek knowledge, cultivate a 'divine discontent' and have courage. They might not then long remain small.

HARDENABILITY OF STEEL

IN the spring of 1943 a small mission of British metallurgists visited the United States and Canada to discuss the extent to which economy in the use of alloys required for the production of certain special steels could be still further increased. The problem arose from the fact that some of the alloying metals in common use in peace-time were not then available in quantity sufficient to meet the whole of the requirements of the Allies, and alternative steels had to be devised. A most comprehensive account of some of the work done in this direction is included in a "Symposium on the Hardenability of Steel" published by the Iron and Steel Institute, and discussed at a meeting of that Institute on May 14. It should be pointed out—a fact which was not always remembered during the actual discussion—that this work was done under the stress of war-time conditions and that, therefore, there are numerous problems which still await more detailed examination. Fundamental questions of the greatest interest have emerged, and many fields for further work opened up.

The major portion of the papers deal with the end-quench hardenability test—usually known by the name of the 'Jominy test'—the interpretation of the results obtained, and the possibility of using these to predict the extent to which bars of different diameter can be hardened. The influence of boron in increasing

hardenability, and, therefore, its potential value in the reduction of the amount of other alloying elements required, is another problem to which attention has been given.

The Jominy test itself has received careful scrutiny, and a most valuable standard procedure for carrying out such investigations drawn up. It must be realized immediately that, in this test, hardness measurements alone are made, and other mechanical properties, therefore, are not taken into consideration. It is well known, however, that these properties, the notched-bar test for example, may vary to a very considerable extent, even with the same steel, and in a condition of identical hardness; the 'temper-brittleness' of some nickel-chrome steels affords an excellent example of this fact. It is clear, then, that while the intelligent use of the end-quench hardenability test may be of great value in providing a preliminary classification of different types of steel, it is equally important to realize that it does not obviate the necessity for other tests where ductility and toughness are of importance.

In view of the 400 pages of papers submitted, the Committee has done well to publish an agreed statement of the principal conclusions reached.

In connexion with the reproducibility of the curves obtained from the Jominy test, it is concluded that the end-quench test is capable of yielding satisfactorily reproducible results provided that the material under test is homogeneous, and that these results are not appreciably affected by small changes in the conditions under which the test is carried out. The end-quench curves determined on different samples of the same ingot, whether forged or rolled to approximately the diameter of the specimen, generally show only small differences. Further, the curves determined on samples from different ingots of the same cast of steel also in general show only minor variations. A marked variation of hardenability may, however, exist across the section even of a single bar, and in general, though not invariably, the hardenability at the centre is less than that at the surface. The hardenability of a steel may also be slightly affected by a variation of the microstructure before quenching. An examination of the hardenability of a hyper-eutectoid chromium–molybdenum steel, for example, suggests that the amount and distribution of the free carbide has a significant effect.

In connexion with the relationship of hardenability and chemical composition, the Committee reports that a wide variation in end-quench hardenability may exist between different casts of steel produced to the same specification, and that even when the variation of composition is taken into account, the hardenability cannot always be calculated satisfactorily from a knowledge of this and the grain size. Dealing with the prediction of the hardness of quenched, and quenched and tempered, bars from hardenability curves, it is concluded that the hardness curves of an oil-quenched bar across its diameter cannot be derived consistently and with adequate accuracy from a single end-quench curve, but that the hardness of a quenched and tempered bar may be predicted satisfactorily from a test specimen which has been end-quenched and afterwards tempered. The combination of mechanical properties obtained from steel that has been quenched and then tempered in the range 500°–650° C. depends on the hardness developed by quenching; but there are as yet serious difficulties in interpreting end-quench curves in terms of the ability of steels to attain any required combination of mechanical properties. Further, the transformation-temperature ranges of steels during continuous cooling can be determined approximately from a series of interrupted end-quench tests.

The Committee, at first under the chairmanship of the late Dr. T. Swindon, and later under that of Mr. D. A. Oliver, has done an admirable piece of work. Where all are so good, it is invidious to pick out any one contribution, but the writer may, perhaps, be allowed to mention his own special interest in Mr. T. F. Russell's theoretical treatment of the Jominy test.

Throughout this work the fullest acknowledgment is made to the previous researches of Grossman, Jominy and their collaborators. Further, Crofts and Lamont of the Union Carbide & Carbon Research Laboratories, Niagara Falls, have delayed publication of their other early and extensive researches for inclusion in this publication.

Some idea of the scope of the interest shown in recent years is provided by a bibliography of 255 papers, all published between 1938 and 1944.

F. C. T.

SOCIAL VALUE OF WAR-TIME MEDICAL RESEARCH

SIR ALEXANDER BIGGAM has published a valuable paper on "War-time Advances in Medicine which might be translated into Civil Practice" (*Edin. Med. J.*, **53**, 413; Aug. 1946). In a world war, he says, some medical problems become so important that solutions of them must be found at all costs and, during the Second World War, the attacks upon these problems led to important advances in our knowledge, especially in the practice of preventive medicine.

One of the greatest enemies of the Allied Forces overseas was malaria. It could be argued, in fact, that malaria was our greatest enemy, and it is still the most formidable of the epidemic diseases which attack man. Sir Alexander states that it caused, in Burma at the beginning of the recent war there, nearly half the total sickness experienced. Intensive research on methods of control was therefore imperative, and an enormous amount of research was done. It was greatly helped by volunteers who included members of the Friends Ambulance Unit, students at the University of Oxford, where the Army Malaria Research Unit was situated, and soldiers serving at the Army Medical College. Much research was done elsewhere, and notes upon it have appeared from time to time in *Nature*. The advent of D.D.T., which kills the mosquitoes, and of dimethyl phthalate and other repellents, and of mepacrine, paludrine and the latest addition to our antimalarial drugs, *SN* 13276, have enormously increased our control of malaria. Sir Alexander tells us how these weapons were used in the Far East. His account may be compared with the fascinating story of the eradication of *Anopheles gambiæ* from Brazil by a team working for the Brazilian Government and the Rockefeller Foundation (see *Nature*, **153**, 765; 1944), a remarkable feat which has been repeated by the same workers in Egypt, where, in the Nile Valley in Upper Egypt in 1943, some 130,000 people died of malaria transmitted by this species of mosquito (see Rockefeller Founda-

tion Report, 1946). A valuable account of the principles and methods of malaria control has also been given by Dr. G. Macdonald, director of the Ross Institute, in his "Notes on Malaria and its Control for Planters and Miners" (April 1946), a pamphlet which discusses, in addition to the principles and methods of control, the malarial parasite itself, its main carriers in the British Empire, the types of land associated with malaria in Malaya and the factors which affect the incidence of malaria.

Another major menace of the Allied Forces in the East was bacillary dysentery. In the British Forces this was treated with sulphaguanidine, but the United States medical men preferred sulphadiazine, which was, they claimed, more effective. Sulphaguanidine, however, is less likely to affect the kidney, and British opinion, therefore, considered that it was preferable in tropical countries where much fluid is lost by sweating and where the sufferer is often dehydrated. Sir Alexander discusses the use of sulphaguanidine, and also the use of D.D.T. against the flies which spread the organisms which cause bacillary dysentery.

Serious also was amœbic dysentery, and much experience of its control and treatment was gained. Sir Alexander especially mentions the cases which resist treatment; and the view that they do so because secondary pyogenic organisms, which infect the intestinal walls already damaged by *Entamœba histolytica*, render these cases intractable. He quotes the work of W. H. Hargreaves (*Lancet*, ii, 68; 1942), which indicates that a preliminary treatment with penicillin and a sulphonamide drug would remove these secondary organisms, so that the attack upon *E. histolytica* with specific drugs such as emetine bismuth iodide, chiniofon, etc., then produces good results. Sir Alexander outlines the treatment which should be given.

Epidemic typhus was not a serious risk in Burma. Mite-typhus (scrub-typhus) was one of the greatest problems encountered in that country. The control of this disease, which is caused by *Rickettsia orientalis* and is transmitted by the larvæ of the mite *Trombidium akamushi* and perhaps by other species of this genus (see *Nature*, **157**, 236; 1946), was helped by attacks upon the mite with dimethyl phthalate. The remarkable story of the mass production of the vaccine against this disease has been told by Fulton, F., and Joyner, L. (*Lancet*, Dec. 8, 1945, p. 729, and Buckland, F. E., *et al.*, *ibid.*, Dec. 8, 1945, p. 734. See also the *Lancet*, Sept. 8, 1945, p. 308). So serious was the menace of the disease that the production of this vaccine was given the highest priority. Special laboratories were rapidly erected, cotton rats, in the lungs of which the *Rickettsia* develops abundantly, were flown from the United States by the R.A.F., and the devoted work of volunteers, who took very considerable risks of severe illness or death during their work (the accidental infection of four of these workers is described by Van den Ende, M., *et al.* (*Lancet*, July 6, 1946, p. 4)), produced enough of the vaccine to inoculate a considerable number of troops in Burma. The collapse of Japan and the withdrawal of Allied troops from the areas in which the disease was prevalent have made it unlikely that the results of this mass inoculation will now give useful information; but research on the vaccine has not ceased.

The rest of Sir Alexander's article is devoted to notes on typhoid fever, only a few outbreaks of which occurred, to warnings about the use of sulphonamides in the tropics where excessive sweating increases the risk of damage by these drugs to the kidney, to penicillin and to laboratory methods of the diagnosis of smallpox and other diseases. There are interesting notes on the importance of preventing sea-sickness in troops about to cross rough seas. Research done by the Medical Research Council in co-operation with military medical men showed that the most useful remedy for it was 1/100 grain of hyoscine given one hour before embarking and repeated every six hours. If the dose has to be continued over a long period, it must be reduced.

In his note on the work of psychiatrists, Sir Alexander says that the successful placing of men, selected by psychological tests, was one of the successes of the recent war. Important also were centres for physical development. A final note on administration points out that medical personnel in an Army Medical Service are under complete administrative control, so that a study of this Service and of the results obtained by it is especially interesting now that a State medical service is to be introduced in Great Britain.

G. LAPAGE

THE IRISH PILCHARD FISHERY

THE fishery for pilchards (*Sardina pilchardus*, Wal.) off the coasts of Cornwall has been famous for many centuries, and also the French, Spanish and Portuguese fisheries for sardines, which are the same species of fish. It is not generally known, however, that there has been also, at various periods, a flourishing Irish pilchard fishery. The appearance of a detailed historical account of the Irish pilchard fishery is therefore particularly welcome as being at once interesting and instructive*.

An Irish pilchard fishery existed so far back as 1591 and probably earlier; but its activities can be traced with some degree of accuracy only from about the year 1611. This is done comprehensively and in detail in the body of the paper, and is admirably summarized at the end.

The records show that the pilchard, when it frequents Irish waters, does so mainly along the coasts of Waterford, Cork and Kerry, although it is by no means confined to those counties. But the fishery has always exhibited extreme fluctuations, and, in recent times, the pilchard appears to have forsaken Irish waters almost entirely from 1904 until 1935. In the latter year shoals began to reappear, and in 1940 pilchards were plentiful once more off Ireland.

Unfortunately, there appears to be no demand in Ireland now for this fish, either fresh or preserved, and a vast potential source of food is not being exploited. But pilchards are occasionally caught when herring and mackerel are being fished, and even then they are usually thrown back into the sea. Nevertheless, the day yet may come when pilchards will command a ready market, even in Ireland, and this record of what the author calls "pilchard years" will then be invaluable. In the meantime, his paper is an outstanding contribution to our knowledge of this fishery over a very long period, and one hopes that its appearance will stimulate someone in a position to do so to prepare a similar historical account of the Cornish pilchard fishery.

G. A. STEVEN

* *Proc. Roy. Irish Acad.*, **51**, B, No. 5. Pp. 81–120. The Irish Pilchard Fishery. By Arthur E. J. Went. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, 1946.) 2s. 6d.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, June 23

UNIVERSITY COLLEGE, LONDON (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Prof. Kapp: "The Presentation of Technical Information", Second Series, 4: "Some Specific Problems".*

Wednesday, June 25

INSTITUTE OF WELDING (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 2.30 p.m.—Annual General Meeting.

Thursday, June 26

PHYSICAL SOCIETY, ACOUSTICS GROUP (at the Royal Institute of British Architects, 66 Portland Place, London, W.1), at 10 a.m.—Summer Symposium on "Sound Absorption and Reverberation".

IRON AND STEEL INSTITUTE (at 4 Grosvenor Gardens, London, S.W.1), at 2.30 p.m.—Mr. F. Fancutt: "The Effect of Different Methods of Pretreating Iron and Steel before Painting"; Mr. J. C. Judson and Mr. T. A. Banfield: "The Protection of Iron and Steel by Metallic Coatings".

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Prof. M. Born, F.R.S., and Mr. H. S. Green: "A Kinetic Theory of Liquids", Parts 1–4.

MINERALOGICAL SOCIETY (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

Friday, June 27

PHYSICAL SOCIETY (in the Physics Department, Imperial College of Science, South Kensington, London, S.W.7), at 5.15 p.m.—D. J. Morgan: "A Model representing the Action of a Full-wave Rectifier" (demonstration); Prof. S. Tolansky: "Applications of Multiple-Beam Interferometry to Surfaces of Thin Films".

Saturday, June 28

SOCIETY FOR ENDOCRINOLOGY (in the Physiology Lecture Theatre, Guy's Hospital Medical School, London, S.E.1), at 10 a.m.—Symposium on "The Assay of Urinary Steroids".

BRITISH PSYCHOLOGICAL SOCIETY (at Bedford College for Women, Regent's Park, London, N.W.1), at 2.30 p.m.—Mr. Sydney Crown: "The Use of a Controlled Association Test as a Measure of Neuroticism"; Mr. E. A. Peel: "A Method for Analysing Value Judgments and Preferences".

Monday, June 23—Saturday, June 28

BRITISH GRASSLAND SOCIETY and the BRITISH SOCIETY OF ANIMAL PRODUCTION (at University College, Aberystwyth).—Joint Summer Meeting.

Friday, June 27—Saturday, June 28

CLARENDON LABORATORY, OXFORD.—Conference on "Liquid Helium".

Friday, June 27

At 2.30 p.m.—Opening of the Conference by Dr. K. Mendelssohn.

Saturday, June 28

At 9.30 a.m.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT MYCOLOGIST in the Plant Pathology Department—The Secretary, Rothamsted Experimental Station, Harpenden, Herts (June 28).

SENIOR TECHNICIAN (Grade A, male), and TECHNICIANS (2, Grade B, male), in the Biochemistry Department, a LABORATORY TECHNICIAN (Grade A) with a good knowledge of photography, and a SENIOR TECHNICIAN (Grade A) for the Physiology Department—The Secretary, Rowett Research Institute, Bucksburn, Aberdeenshire (June 28).

LECTURER IN MECHANICAL AND WORKSHOP ENGINEERING at the County Technical College—The Director of Education (Dept. F.E.), County Education Offices, Stafford (June 28).

RESPONSIBLE TEACHER OF ENGINEERING, and a TEACHER OF MECHANICAL AND PRODUCTION ENGINEERING SUBJECTS, in the Secondary (Technical) School and part-time Senior Classes of the Batley Technical College and School of Art and Crafts—The Acting Divisional Education Officer, Education Offices, Batley, Yorks (June 28).

CEREAL RESEARCH OFFICER, Department of Agriculture, Western Australia—The Agent-General for Western Australia, Savoy House, 115 Strand, London, W.C.2 (June 30).

ASSISTANT MASTERS IN H.M. DOCKYARD SCHOOLS—The Director, Education Department, Admiralty, London, S.W.1 (June 30).

JUNIOR LECTURER, and an ASSISTANT, IN MEDICAL STATISTICS—The Secretary, The University, Edinburgh (June 30).

SPEECH THERAPIST—The Clerk of the County Council, County Hall, Newport, Isle of Wight (June 30).

LECTURER or ASSISTANT LECTURER IN THE DEPARTMENT OF BIOCHEMISTRY—The Registrar, The University, Liverpool (July 1).

SENIOR LECTURER IN AGRICULTURE AND BOOKKEEPING, an ASSISTANT LECTURER IN AGRICULTURE, a JUNIOR ASSISTANT LECTURER IN AGRICULTURE, and a JUNIOR ASSISTANT IN THE POULTRY SCHOOL, Auchincruive—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow (July 5).

LECTURER IN BIOCHEMISTRY—The Registrar, The University, Leeds 2 (July 7).

LECTURER IN ZOOLOGY, an ASSISTANT LECTURER IN ZOOLOGY, a LECTURER IN BIOCHEMISTRY, and a LECTURER IN PHYSIOLOGY—The Registrar, The University, Leeds 2 (July 7).

SENIOR CYTO-GENETICIST at Shambat, near Khartoum—The Secretary, Empire Cotton Growing Corporation, 1a Harrington Road, London, S.W.7 (July 12).

RESEARCH PHYSICIST—The Ministry of Labour and National Service, Technical and Scientific Register, Room 171, York House, Kingsway, London, W.C.2, quoting A.158/47A (July 12).

SENIOR LECTURER IN PHYSICAL CHEMISTRY in the Auckland University College, New Zealand—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (July 15).

LECTURER IN CIVIL ENGINEERING in the University of the Witwatersrand, Johannesburg—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (July 16).

REGIONAL FUEL ENGINEERS, male (London and provinces)—The Director of Establishments, Ministry of Fuel and Power, 7 Millbank, London, S.W.1, quoting 'Regional Fuel Engineer' (July 21).

SECOND ASSISTANT TO THE CITY ANALYST—The Secretary and Registrar, The University, Bristol, endorsed 'Second Assistant Analyst' (July 21).

LECTURER IN MATHEMATICS in the Canterbury University College, Christchurch, New Zealand—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (July 31).

PROFESSOR OF DAIRY HUSBANDRY in Massey Agricultural College, Palmerston North, New Zealand—The High Commissioner for New Zealand, 415 Strand, London, W.C.2 (September 1).

SCIENTIFIC ASSISTANT—The Director, Imperial Bureau of Animal Nutrition, Rowett Research Institute, Bucksburn, Aberdeenshire.

BOTANIST to undertake research on problems relating to the cultivation of *Hevea brasiliensis*—The Secretary, London Advisory Committee for Rubber Research (Ceylon and Malaya), Imperial Institute, London, S.W.7.

WORKSHOP TECHNICIAN, and SENIOR LABORATORY ASSISTANTS (2, men or women), in the Department of Chemistry; a LABORATORY STEWARD (man or woman), and a DEPARTMENTAL ASSISTANT (woman) interested in museum and herbarium work, in the Department of Botany; and a LABORATORY TECHNICIAN, in the Department of Geology—The Registrar, University College, Nottingham.

LECTURER, and a SENIOR ASSISTANT, IN THE PHYSICS DEPARTMENT—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1.

LECTURERS (2) IN THE DEPARTMENT OF PURE AND APPLIED SCIENCE (one should be qualified to teach Elementary Metallurgy, the other should be qualified in Physics)—The Registrar, Loughborough College, Loughborough.

LECTURER IN CHEMISTRY—The Clerk to the Governing Body, Battersea Polytechnic, Battersea, London, S.W.11.

LECTURER IN THE ELECTRICAL ENGINEERING DEPARTMENT—The Secretary, Royal Technical College, Glasgow.

LECTURER IN CHEMISTRY, a LECTURER IN BIOLOGY, a LECTURER IN GENERAL ENGINEERING SUBJECTS, a LECTURER IN PHARMACOGNOSY, and a SENIOR ASSISTANT IN MATHEMATICS—The Registrar, Municipal College, Portsmouth.

ASSISTANT for abstracting, reviewing and indexing literature on forestry and forest products—The Director, Imperial Forestry Bureau, Oxford.

LECTURER IN ELECTRONICS—The Head of the Electrical Engineering Department, Imperial College, South Kensington, London, S.W.7.

LECTURERS IN MATHEMATICS (one in Grade II and two in Grade III), and a LECTURER (Grade III) in PHYSICS—The Clerk, Birkbeck College, Breams Buildings, London, E.C.4.

LECTURER, and an ASSISTANT LECTURER, IN THE DEPARTMENT OF ZOOLOGY—The Secretary, University College, Gower Street, London, W.C.1.

GRADUATE IN ENGINEERING SUBJECTS with special qualifications in thermodynamics—The Principal, Erith Technical College, Erith Road, Belvedere, Kent.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Other Countries

Smithsonian Miscellaneous Collections. Vol. 106, No. 14: A New Dussumieriid Fish of the Genus Jenkinsia from Bermuda. By Luis Rene Rivas. (Publication 3859.) Pp. ii + 4 + 1 plate. (Washington, D.C.: Smithsonian Institution, 1946.) [91

U.S. Department of Agriculture. Picture Sheet No. 15: Boll Weevil. Pp. 2. 5 cents. Picture Sheet No. 16: Bollworm. Pp. 2. 5 cents. Picture Sheet No. 17: Cotton Aphid. Pp. 2. 5 cents. Picture Sheet No. 18: Cotton Flea Hopper. Pp. 2. 5 cents. Picture Sheet No. 19: Cotton Leafworm. Pp. 2. 5 cents. Picture Sheet No. 20: Red Spider. Pp. 2. 5 cents. (Washington, D.C.: Government Printing Office, 1946.) [91

Television: a Bibliography of Technical Papers by RCA Authors, 1929-1946. Pp. ii + 10. (Princeton, N.J.: Radio Corporation of America, 1946.) [91

League of Nations: Economic, Financial and Transit Department. Food, Famine and Relief, 1940-1946. (II. Economic and Financial, 1946. II. A. 5.) Pp. iv + 162. 6s. net. The Population of the Soviet Union: History and Prospects. By Frank Lorimer. (II. Economic and Financial, 1946. II. A. 3.) Pp xiv + 294. 15s. net. (Geneva: League of Nations; London: George Allen and Unwin, Ltd., 1946.) [91